THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 30. Thursday, December 18, 1924. No. 435

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum.
Foreign and Colonial, 17s. 6d. per annum.
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
BESSEMER HOUSE, 5, DUKE STREET, ADELPHI,
LONDON, W.C.2.

Contents.

	PAGE
The Foundry Metallurgist	513
The Foundrymen's Part in Aeroplane Production	514
Two Foundry Casualties	514
Mr. Hollinworth's Illness	514
Institute of British Foundrymen	514
Some Further Reflections on Continental Foundry Methods	515
A Neat Coring Job	518
Contraction Stress: Cause and the Remedies	519
Fixing the Responsibility for Foundry Defects	523
Shrinkage, Composition and Contraction of Cast Iron	524
Molecular Equilibrium in Grey Iron Castings	524
The Selling of Castings—VI	526
Fatigue in Metals	527
Wheel Mould Cores	528
Trade Talk	530
Company News	530
Contracts Open	530
Obituary	530
Iron and Steel Output	530
Iron and Steel Markets	532

Forthcoming Events.

DECEMBER 19.

Institute of British Foundrymen (London Branch):—Annual dinner in London.

Institute of British Foundrymen (Sheffield Branch):—Lecture at Fargate. "Small-work Moulding in Green and Dry Sand," Paper by J. D. Nicholson.

Institution of Locomotive Engineers (London):—General meeting in London.

Institution of Mechanical Engineers:—General meeting in London.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT, 1924-25, R. O. Patterson, Blaydon-on-Tyne.

LIST OF SECRETARIES—

General Secretary: W. G. Hollinworth, 38, Victoria Street, London, S.W.1.
Lancashire: T. Makemson, 21, Beresford Road, Gorse Hill, Stretford, Manchester.
Birmingham: H. James Roe, 33, Herbert Road, Bearwood, Birmingham.
Sheffield: R. Village, Albion Foundry, Whittington Moor, near Chesterfield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.
Newcastle-on-Tyne: Colin Gresty, 93, Queen's Road, Monkseaton, Northumberland.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
Coventry: J. M. Meston, Priory House, Priory Street.
West Riding of Yorkshire Branch: A. Love, 232, Gladstone Street, Bradford.
Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitechurch, Glam.

Welsh Engineers' and Founders' Association.

Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

The Foundry Metallurgist.

If the prophets are to be believed, there is to be a continuous increase in the volume of business during the coming year. If this is to be relied upon, then we will prophesy that many foundries will employ a metallurgist for the first time in their existence. The success or failure of this experiment will be determined during the first month of its operation. This is due to a combination of two factors. Primarily, the management usually has but a hazy notion of the duties of a metallurgist, and, secondly, the metallurgist has no idea of what is expected of him. Unless the two evolve at the inception a clear and definite policy, the result will be the building and equipping of a chemical laboratory and the auto-manufacture of still another routine chemist.

We suggest that the policy to be pursued is the acceptance of the following basic principles:—(1) The metallurgist should advise the directorate on every question which can have a metallurgical aspect; (2) he should catalogue and report upon, where necessary, all waster castings produced; (3) he should gradually assume control of the melting plant and the raw materials; (4) he should investigate existing costs before recommending a single technical change; (5) he should co-operate with the buying department and stores; and (6) institute a special library and information bureau.

The first question upon which he will probably be called upon to advise his directors is the installation of a chemical laboratory or perhaps the resurrection of a derelict one. In fact, this may be the *raison d'être* of his appointment. If he is wise he will make every effort to convince his chiefs that the laboratory is only one of his tools, and that it is preferable to have analytical work performed by an outside firm. The cost of this may be higher or lower than the running of a works laboratory, but unless the costs are taken over a period in an intelligent fashion there is but little data upon which to decide. For the average foundry he would be well advised to instruct an intelligent youth in the handling of a simple sand-testing apparatus; then should follow the installation of a micrographic apparatus. Some simple mechanical-testing apparatus such as the Brinell, transverse, Izod, and shrinkage tests should also be regularly used.

Routine work must be counted a normal manufacturing cost, but there should immediately be created an experimental account of a substantial character, so that manufacturing costs are not unduly increased thereby.

The metallurgist usually has but little engineering knowledge, and even less practical foundry *connaissance*. If he is to be of maximum value to his firm he must co-operate from the first day of his appointment with the foundry foremen and the works engineers. Successfully to accomplish this, he must rid himself of what psychologists call the "importancy complex." Co-operation will perhaps be best secured by interesting the foundry foreman in some simple physical experiments, and always alluding to work "which we are going to carry out," or "which we have made."

When the metallurgist has assumed an integral part of the management of a concern then it is time to consider the installation of a *modern* suitably staffed chemical laboratory. The one-man inefficiently controlled chemical laboratory has done more to injure the reputation of the metallurgist in the eyes of the practical man than any other factor.

To obtain the best work from a works metal-

lurgist, the directors must allow him full scope to keep up to date. He must be permitted to represent them at technical conferences and exhibitions. He must be encouraged to form a special library and information bureau. The majority of works problems are already solved, and the information is available, but, unfortunately, it is usually difficult to find, as our Foundry Queries quite often demonstrate.

The metallurgist's professional training bestows upon him the *droit d'entré* into a foundry, but this, like influence, only gets him the job. Once established, the indefinable "common sense" takes up anything between 80 and 95 per cent. of his business-thought output.

The Foundryman's Part in Aeroplane Production.

BY M. E. NICHOLLS.

Since the war the progress of aeroplane manufacture has been steady, and if it has not yet reached the point predicted by many who years ago saw in aero locomotion an industrial extension of some magnitude, it has indeed reached the point when the commercial possibilities of the enterprise begin to take concrete form.

This being the case, it may be taken for granted that the experimental stage in the manufacture of aeroplanes has passed, and although it is not likely that mass production methods will ever be associated with this industry, quantity production is by no means out of the question. Instead of tens and twenties, it will soon be the rule to produce a hundred or more machines to one design, and even when there is a changed design it will be found that many of the details will remain unaltered, so that the quantity required will be considerable.

This will apply particularly to engine details, and this should be of interest to foundrymen, seeing that it is in connection with the aero engine that the greater number of castings are needed. Another point, too, that might be stressed is that British aero engines are already famous throughout the world, and are being purchased by foreign aeroplane manufacturers for use in connection with their own machines.

As the results of defects in the construction of an aeroplane are likely to be serious, the material used must be the best of its kind, but for the making of aeroplanes to be regarded as a commercial proposition prices have got to be kept within reasonable limits. There is no doubt that castings can be obtained that will satisfy the most exacting, but there is some doubt as to whether these satisfactory castings can be obtained at a price that will allow the production of aeroplanes to be carried out on a commercial basis.

That many founders are determined that this shall be accomplished may be taken for granted, and the fact that aluminium alloy pistons are now being die cast successfully suggests that practical steps have already been taken. In this connection, however, the present costs are still abnormally high, this being due to the expense associated with tools and equipment, which cannot really be covered by the relatively small number of castings ordered. This disability will pass away when quantity production becomes an accomplished fact, and in the meantime the founder must take such orders as are going, and seek to qualify for a goodly share of what will be available in the future.

At the present time, too, inspection is very irksome, and contributes largely to delay and expense. It has to be remembered, however, that inspection of aircraft details involves responsibilities not met with in other phases of industry, for an apparently slight defect may result in loss of life. The inspectors, therefore, do well to be suspicious, and to insist upon the most searching tests, but as time goes on confidence will be instituted, and as regards inspection the consistently good workmanship and care in respect to detail will allow a certain relaxation.

So far as aero engine details are concerned, the crankcase is by far the most expensive, and the least satisfactory. This is rather surprising when one considers the successes achieved by founders in regard to automobile crankcases. The aero crankcase may be more intricate, though this is largely the fault of design, but that appears to be little reason for the lack of progress made. There is very little to choose between the aero crankcase made in 1916 and the one made in 1924, either in respect to cost or workmanship, and it would seem that there has been but little research work in the foundry in respect to this detail.

In regard to the smaller details, those cast from non-ferrous metals include bearings, bushes, oil and water-pump casings, etc., whilst the iron foundry is interested in piston rings, valve guides, cylinder liners, and certain types of pistons. In the earlier days of the aero industry there was a tendency to squeeze the iron foundry out, but nowadays its importance is coming to be recognised, and there is no reason why in the future it should not become a very important branch of the industry.

To sum up, it behoves all automobile and similar foundrymen to give attention to the aero industry, with a view to ascertaining what advantages can accrue to them. There seems no doubt that in a few years quantity production will become an accomplished fact, but this depends to no little extent upon the action taken by the founding industry. If the founders are prepared to do their part by producing really sound castings at an economical figure, the production of aeroplanes will increase amazingly, and will in a short time completely revolutionise transport.

Institute of British Foundrymen.

NEWCASTLE JUNIOR SECTION.

A Successful Smoking Concert.

A successful smoking concert was held in Eshelby's Café, Newcastle, on December 12. Mr. J. E. O. Little (senior Vice-President) presided over a large assembly.

The programme for the evening included songs by Messrs. S. S. McIntyre, W. Rutledge, J. W. Eckford, T. Harvey and C. Hibbs, with Mr. Liddell at the piano.

During the evening MR. FRIER (Newcastle Branch President) appealed to the junior members to sacrifice some of their pleasures in order to attend the meetings of the Branch and its Junior Section. He assured them that it would be well worth their while to do so, because they would benefit from it in after life.

MR. SPENCE, referring to the question of membership, said that, if agreeable to the Branch, he was prepared to offer a prize to the member of either the Branch or the Junior Section who obtained the largest number of members for the latter during the next twelve months, and another prize to the one who obtained a certain number. He would also give a special prize to the member who introduced the largest number of foundry apprentices to the Junior Section.

On the motion of MR. LITTLE, a hearty vote of thanks was accorded to MR. SPENCE for his kind offer.

Two Foundry Casualties.

The inquiry respecting the death of Walter Langley, a cupola hand, of 85, Inkerman Street, Vauxhall, who was killed by falling into the cupola in the course of his employment at the foundry of the Midland Railway Carriage & Wagon Company, Common Lane, Washwood Heath, on December 10, has been postponed until December 30. During the rescue operations several other men were injured. Their conduct was eulogised by the doctor who was called in.

J. M. Connell was killed through a hoist accident at Smith & Wellstood's foundry at Bonnybridge on December 12.

Mr. Hollinworth's Illness.

We are pleased to report that Mr. W. G. Hollinworth, the general secretary of the Institute of British Foundrymen, has now passed the crisis in his illness, which was of the nature of a stroke. It will, of course, be many weeks before he can resume his business.

Some Further Reflections on Continental Foundry Methods.*

By A. S. Beech, M.I.Brit.F., M.A.T.F. (*France*).

Introduction.

In November, 1923, the author had the honour of addressing the London Branch of the Institute of British Foundrymen on the subject of "Continental Foundry Practice."

During the course of that Paper he referred to pattern-plate and stripping-plate making, hydraulic squeezing of moulds, jolting of moulds, sand preparation, sand conveying, and the importation of Continental castings into Great Britain. It will be evident to everybody that such a Paper could only give a very brief and curtailed *résumé* of the various subjects, and hence he makes no apology for again referring to this most important subject.

The importance of studying other countries' ideas, especially at the present moment when Britain is struggling for the trade of the world, cannot be over-estimated, and obviously there are points to be learned from our *confrères* abroad. It is necessary to cast away all existing prejudices about new innovations and face the fact that unless Britain saves the minutes or even the seconds in production, it cannot hope to regain its export trade or even to maintain its home trade. The present position is that there is vastly more competition from foreign nations than there was in pre-war days.

In addition to this, Britain has to combat against Exchanges on the Continent reduced in many cases to ridiculous figures, abnormal domestic taxation, and perhaps, most of all, reduced output per man per hour, and less working hours than in pre-war days. In addition, there are very high rail and freightage charges, and finally, it is very difficult to visualise how these great difficulties are to be overcome. However, fortunately the Britisher, in the right frame of mind, backed up by fair and correct management and supplied with the best tools and plant, is second to none in the world.

On the Continent of Europe to-day everybody is working harder than here, not only the men and women in the works, but also the directors and the office staffs. A walk in any of our large cities from nine o'clock to ten-thirty or even eleven o'clock in the morning shows what should be responsible people going leisurely to work, but rushing away again about five to five-thirty in the evening.

It is a curious thing that these are generally the people who find fault with the people in the works for not working sufficiently hard. No good can be done by making excuses for the people in the works, because without doubt, with the aftermath of the war, there seems to have come over everybody a desire for less work and more pleasure, and as a result to-day we are faced with the fact that large numbers of the population can find no work, and are existing on the donations provided by those who are working.

One of the main reasons why Britain is not getting trade is that the Britisher, as a whole and not as individuals or as an individual class, are not working as hard as their Continental *confrères*.

For example, the office staff, both male and female, in France generally commence their work at 9 a.m. and finish at 7 p.m., and many of them work all day on Saturdays.

It is obvious that in a general engineering shop the management would not put down one type of machine for all classes of work, say a shaper to do its own natural work and also to do drilling work; but in many foundries in Great Britain the question as to which is the best type of moulding machine for the work has not entered into the matter, and there should be a more thorough investigation on this important point when companies are considering the installation of this type of plant. In pre-war days in Great Britain most companies purchased jolt machines actuated by compressed air, mainly because most British makers of moulding machines had copied the American makers who first invented jolting machines. It is curious, however, that well-known American makers have advocated the use of the "squeezer" machine for shallow work. Mr. Wilfrid Lewis, speaking at the Franklin Institute, Philadelphia, said: "The jar-ramming machine will not ram small work as quickly as a squeezer machine, and for such work a jarring machine for half moulds weighing less than 1,000 lbs. is not often recommended."

The reasons for this statement are quite clear on examination, because it will be found that in America the usual agent for operating the machines is compressed air.

It would appear that this is due to the fact that compressed air is claimed to be an American invention; and also to the complete lack of economy amongst the American people. Hence, as only 100 lbs. per sq. in. as a maximum can be obtained by means of compressed air, it is impossible to squeeze large moulds, unless the diameter of the pistons were considerably enlarged, which would make the machine very costly and very clumsy. On the other hand, squeeze machines can be used to very great depths if the agency employed for working is the correct one, and to be the correct one it will easily be understood that the amount of pressure given by compressed air is not sufficient. With hydraulic pressure one can obtain 750 lbs. per sq. in. working pressure on the accumulator, or even as high as 1,500 lbs. per sq. in. or more if necessary.

Therefore, when Mr. Wilfrid Lewis and other advocates of compressed air machines say that the squeeze is better and quicker for small moulds, the author suggests that if they had larger amount of pressure per sq. in. they would have easily been able to squeeze the larger and deeper moulds quicker than the jolted moulds. It is simply a question of the amount of pressure available, and this is exactly the point so forcibly demonstrated and practised by Continental foundries when they use almost exclusively hydraulic pressure machines.

Perhaps a more important point still is the question of power consumed, and here again the hydraulic method bears no comparison with compressed air. It is possible, and in fact it is being done every day of the week on the Continent, to work twenty hydraulic machines with a 5-h.p. hydraulic pump.

No comparison between this and compressed air will be made, because anyone who is using compressed air will understand that it would take much more power than 5 h.p. to drive twenty compressed-air machines. Mr. A. Wardle, speaking in Birmingham on April 2, 1921, said: "It is important to stop the smallest leakage in the air-pipe system. A ¼-in. diameter hole would allow air at 100-lbs. pressure to escape at the rate of 100 cub. ft. per minute, and 20 h.p. would be required to enable the compressor to cope with this leakage."

Pattern Drawing.

Hydraulic machines give steady, sweet and an even draw, and it is therefore not surprising to hear that some makers of jolting machines now state that their latest machines draw the pattern, through the medium of a cushion of oil, but in saying this they confess that hydraulic pattern-drawing is superior, because this method is hydraulic. These statements have been made to illustrate what is perhaps a further reason why castings are made more cheaply on the Continent.

Over 90 per cent. of the Continental foundries are fitted with hydraulic machines, some of them running as many as 150 to 200 machines in one shop, many having over 100 machines, whilst 40 to 50 machines are quite common, and that these indicate quite clearly that hydraulic machines are

D

* A Paper read at Falkirk before I.B.F., on Saturday, November 15, 1924 Mr. Jas. Walker presiding.

quick in operation, sweet and steady in pattern-drawing and are very cheaply operated. These views have gained considerable ground in Great Britain since the war, and it is remarkable to hear the enthusiastic opinions of the various foundry managers. Mr. E. H. Browne, of London, speaking in Birmingham at the Foundry Exhibition Congress, held in June, 1924, said, "For machines, particularly those for moulding purposes, the author strongly recommends the avoidance of pneumatic power where possible. For pressure-type moulding machines the cost of power for operating is very much cheaper with the hydraulic type, the actual difference depending very largely on the efficiency of the air mains."

Fig. 1 shows a portion of a large installation of

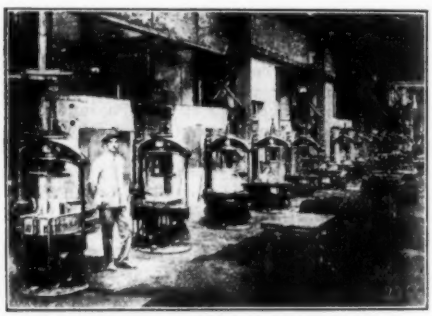


FIG. 1.—A CONTINENTAL INSTALLATION OF HYDRAULIC MOULDING MACHINES.

hydraulic moulding machines; there are over 200 such machines in this foundry. Fig. 2 illustrates a small corner of a Yorkshire foundry. It shows the machine in the centre, together with the output figure written by the firm themselves. It will also be noted that all these moulds are on the floor ready for casting, and that there are no moulding boxes used for casting. The output given on the board is "144 complete moulds in 7½ hours with two men." This figure was obtained in January, 1923, but the foundry manager recently informed the author that he is now getting 172 moulds in 7½ hours with two men.

In each of these moulds are two brake blocks, and the total weight of the castings and gates is approximately 63 lbs. All of these are cast with-

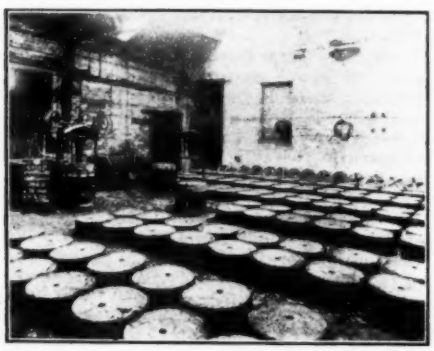


FIG. 2.—A CORNER OF A BRITISH FOUNDRY. THE INSTALLATION MAKES 172 COMPLETE MOULDS IN 7½ HOURS WITH TWO MEN.

out moulding boxes. The method of operation is to mould the cope-mould on one of the moulding machines shown in Fig. 2 and the drag-mould on a second machine. The drag-mould is then placed on the assembling and pushing-out machine in the centre. The cope is then placed over the drag and the pressure is applied.

The assembling machine closes the boxes and then pushes out the block of sand on a cast-iron plate ready to be lifted on to the floor.

It should be understood that hoop-iron bands—one in the cope and one in the drag—are put into the mould during the moulding operation on the joint line in order to resist lateral pressure of the metal during pouring operations. No shields or frames are used during pouring. During the pouring the flat iron weights shown against the wall are placed on the top of each mould. This method again shows economy in production of castings, because not only are all moulding boxes dispensed with except the pair in use on the machines, but also valuable foundry floor space is not being taken up. This is most important, because it has been truthfully said that a "foundry lives on its floor space." For forming the runner-gate a piece of india-rubber shaped to the size and shape of the runner required is placed on the cope pattern.

Under pressure from the machine this rubber is reduced in length but naturally increased in diameter.

When the pressure is released the rubber gate springs into its normal position, leaving a clean-cut runner gate, thus again saving time.

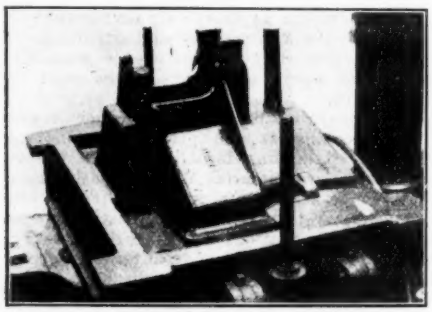


FIG. 3.—A PATTERN PLATE WITH STRIPPING PLATE MADE ENTIRELY BY A MOULDER.

Perhaps the most interesting saving in Continental foundry practice is in the pattern-plate making and stripping-plate and core-box making.

In the first case, pattern-plates and stripping-plates are made entirely without any machining, being simply the work of a moulder alone. The pattern-plate and stripping-plate are cast both at the same time, the stripping-plate being moulded to a knife edge and separated after casting with a small knife or sharpened flat piece of knife steel. It would, however, take a great amount of space to explain the methods used, but it may be pointed out that by using these methods, one is not confined to a flat joint for the stripping-plate, the joint can be raised or lowered to suit the job. This is very interesting because, despite anything that has been said to the contrary, the stripping-plate is still the safest method of drawing a pattern.

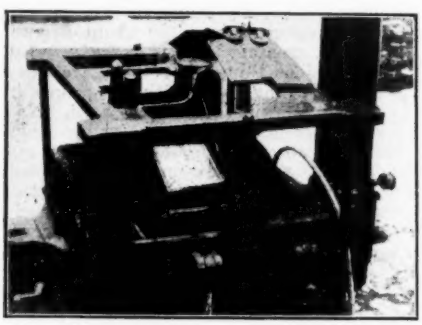


FIG. 4.—THE PLATE ILLUSTRATED IN FIG. 3, BUT WITH STRIPPING PLATE AND THE LOOSE PIECES DRAWN AWAY.

These plates, however, can be made with or without stripping-plates, without any machining, simply by being rubbed over with sand-paper after casting. They are backed up at the back with cement. Further, although the pattern-plates with reasonable care are capable of giving at least thirty to forty thousand castings or more before any repairs are needed, it must be remembered that when they are finished with they can be melted down again and the metal re-used, thus the cost of the job is simply moulder's wages, the material never being lost.

This opens naturally a new field of activity for the moulding machine, because obviously if the initial cost of the pattern-plates is low, it is possible to put castings on the machine for even

smaller quantities than hitherto would have been considered unprofitable, owing to the high initial cost of the pattern-plates.

Another point, and a most important point to be stressed, is that with this method of pattern-plate making, worked in conjunction with moulding machines, it is often possible to leave cores, green sand in the mould.

This is a great saving, not only from the view of core-making, but also where dry-sand cores have been placed; "fins" are left on the casting, thus increasing the fettling costs.

Fig. 3 shows a pattern-plate made at the works of Messrs. The Austin Motor Company, Birmingham. This particular pattern-plate is of a very

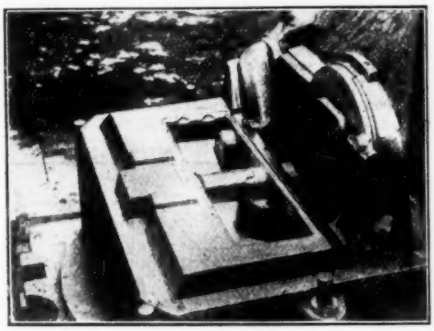


FIG. 5.—ANOTHER TYPE OF PATTERN PLATE.

intricate nature and has been made without any machining whatsoever, and the stripping-plates, loose pieces and pattern-plates have all been made by a moulder alone. Fig. 4 shows the stripping-plate and loose pieces drawn away from the pattern-plate, and indicates, somewhat, its intricate nature. Figs. 5 and 6 show another pattern-plate used by the same company, and this is particularly interesting because it has no less than eleven loose pieces in it, and it indicates to a great extent the intricate nature of the casting which had to be made. Fig. 6 shows the pattern-plate with all the loose pieces drawn away from the pattern. This particular casting, as will be seen from the pattern-plate, is a very difficult one to make, and the ordinary practice in Great Britain would

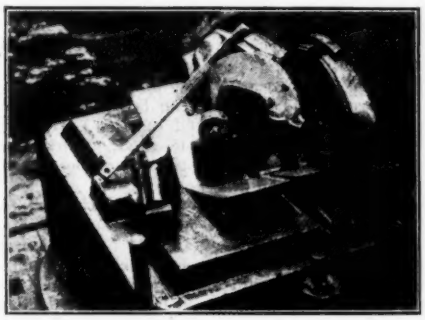


FIG. 6.—THE PLATE ILLUSTRATED IN FIG. 5, BUT WITH THE INTERNAL STRIPPING PLATE AND LOOSE PIECES DRAWN AWAY.

have been to have made an envelope and inserted cores, but with these methods many dry-sand cores have been eliminated and the saving is without doubt very considerable.

Fig. 7 shows a plain pattern-plate made without any stripping-plate but with internal lifting stools in order to do away with coring, and Fig. 8 illustrates a simple job with a stripping-plate which has been stripped to very fine limits. All these pattern plates and stripping plates have been made simply by a moulder alone and with no machinery whatsoever, and moreover the stripping plate has been made to follow the joint line, whether of a flat nature or grooved nature.

Double-faced Pattern Plates.

A double-faced plate made from white metal without machining is shown in Fig. 9. It is very easily made by making two good moulds (top and bottom), placing a rough cast-iron frame in between the two boxes, and pouring white metal into the dove-tails provided in the cast-iron frame.

Ramming of Sands.

In a discussion of this description it is evident that ideal ramming of sands is a most important and far-reaching subject, but it is one also that could be discussed for a long time between us without coming to any satisfactory conclusion.

The jolt-ramming enthusiasts very often claim that ideal ramming is a mould rammed hard at the joint and on the pattern, and soft at the back; to which it could be replied that perhaps their opinion is influenced by the fact that the jolt-ramming machine cannot ram a mould otherwise.

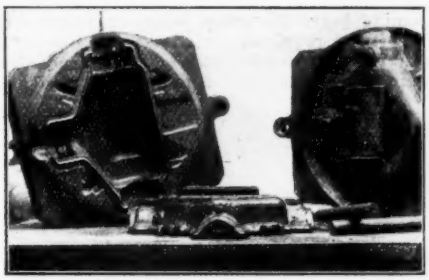


FIG. 7.—A PATTERN PLATE WITH INTERNAL STRIPPING PLATES.

It could also be said that ideal ramming is harder ramming at the bottom of the mould and softer at the top, the pressure of metal forcing the gases out to the atmosphere, being an increasing force from the top to the bottom.

As a matter of fact, all sorts and conditions could be claimed as ideal ramming, because the desired ramming is constantly changing, according to the casting, the quality of sand, the methods of working, etc.

When sand is surrounded by a high part of the pattern, this particular part of the mould has to be rammed "soft," not only because the drawing of the sand will be simplified, but also because the sand at this place has to be more permeable than where there is only metal on one side of the sand. Pressure-ramming enables a mould to be rammed

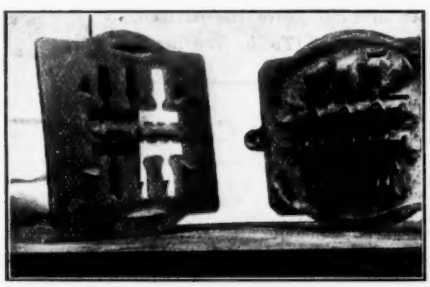


FIG. 8.—ILLUSTRATES A PLATE WHICH STRIPS TO FINE LIMITS.

at different hardness in the mould according to requirements.

This probably is somewhat of a revelation to most foundrymen accustomed to using the jolt ramming machine, and even to some of those who have used the pressure machine without studying sufficiently the conditions. As an example, a box with a pattern of a flat plate, which is of course very suitable for the pressure machine. It is, however, usual to say that the mould will be rammed by the pressure machine harder at the back than at the joint. It is very easily proved that such is not the case. If an equal thickness of sand has been put everywhere, the pressure will be exactly the same in every part of the mould except on the sides, close to the edges of the box.

This cannot be discussed, as it has been proved quite clearly by the use of a small apparatus invented by M. Ronceray of Paris based on the "Brinell" principle for testing the hardness of

a mould. On the sides of the box it will be found that the friction of the sand on the boxes prevents equal ramming of the sand. The same thing would happen on the sides of a pattern, but this difference is not sufficiently important to prevent making a good casting, especially if the proper methods of working are used. These proper methods comprise the use of sand on the dry side, and eventually a little hand-touching on the sharp corners and also, if necessary, a pressure plate of a convenient shape.

For instance, it is quite customary in America to have a pressure plate having a projection around, so as to give a little harder pressure at the place where the friction of the moulding box prevents equal ramming. If there is a projection on the pattern nothing is more easy than to scoop out sand at this place in order to have a softer ramming here, the scoop being in proportion to the softness required.

An English foundry manager has studied very carefully the question of ramming of sands, and

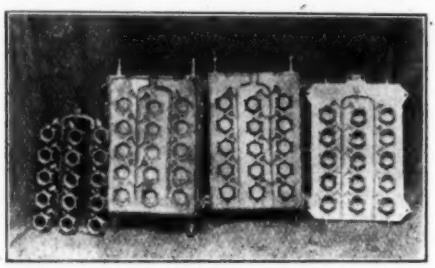


FIG. 9.—A DOUBLE-FACED PATTERN PLATE MADE WITHOUT MACHINERY.

confirms to a great extent what has just been said about ramming of moulds. His conclusions were dealt with by the author in a previous Paper.*

A further point which must be considered with regard to jolting machines is the ramming of a vertical surface. From experiments which have been made in France and in this country, it has been found that on the top part of any vertical surface, especially where a horizontal surface is joining the vertical surface, a soft spot will be found in every case. This sometimes is corrected to a certain extent by the flat ramming, but of course this depends to a great extent upon the depth of sand above the pattern.

(To be continued.)

A Neat Coring Job.

BY J. E.

There are alternative ways of doing most jobs, but there is nearly always one way that is best. It is not suggested that, in all cases where a casting similar to Fig. 1 is required, the method described in this article should be adopted, but it served well for a one-off job that was required at shortest notice. Probably, in most cases, the teeth

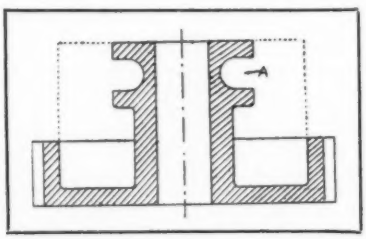


FIG. 1.

would be machined and the boss, with the exception of the centre core, would be left solid.

The illustration indicates a method that is equally as suitable for a repetition job as for a one-off job. The teeth were designed with an odontograph, made in lengths of three teeth to a length, glued in position and subsequently nailed. The teeth were the last part of the pattern to be made. There would have been less difficulty in moulding if the groove A had been machined out, as is often the case, instead of being cored. A solid pattern was made, the portion between the outer rim and the boss being cored out. The dotted line in Fig. 1 indicates the print line. The pattern was, therefore, very simple, and all the work was in the corebox. With regard to the centre core a print was fastened on top of the boss—bottom in the mould—and the core was made in a stock box.

Fig. 2 represents the corebox. Even for a comparatively small job, had many castings been required, it would have been advisable to have built this of segments, or at least have made it of hard timber. Being a one-off job it was made of yellow pine. The illustration makes clear the method of constructing the boss. It was made in

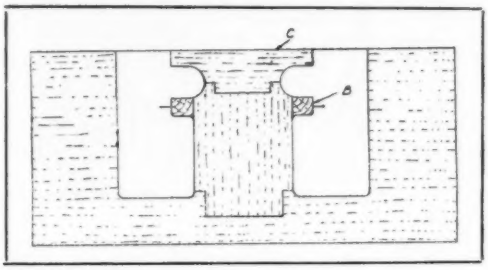


FIG. 2.

two parts, the bottom part being dowelled into a recess turned in the bottom of the box. The top part was also dowelled. The ring B was made in several segments with a key piece which was pinned to the boss. These segments were easily withdrawn by the core-maker.

When making the core, and after it was rammed, the top portion C of the boss was withdrawn first. The bottom part of the boss had, of course, to be drawn out in the opposite direction when the segments B were pulled into the space left by the boss.

A very sound casting was obtained and very quickly. In the patternshop, while one man was turning the block, another was preparing the teeth. Making the teeth was the biggest job, but these were finished in a box and sandpapered on a roller revolving between the lathe centres. The centres of the teeth marked on the periphery of the pattern were carefully marked. Centres were not marked on the teeth, the edges being set to the lines marked on the periphery.

If the groove had not been cored the job could have been made without a corebox, sufficient taper being left on the inner diameter of the rim and the boss to have ensured easy delivery from the sand. The boss would have been jointed in two parts and the top part would have been withdrawn before the core was delivered from the box.

With regard to the corebox, Fig. 2, considerable taper was left. It was very quickly turned, as was also the boss, but the ring B was made at the bench. The job altogether was a neat instance of a design, the construction of which was facilitated by putting all the work into the core.

Foundry Statistics.

ACCORDING to a Blue Book just published by H.M. Stationery Office, there are 129,214 male foundry workers aged 12 and over in England and Wales.

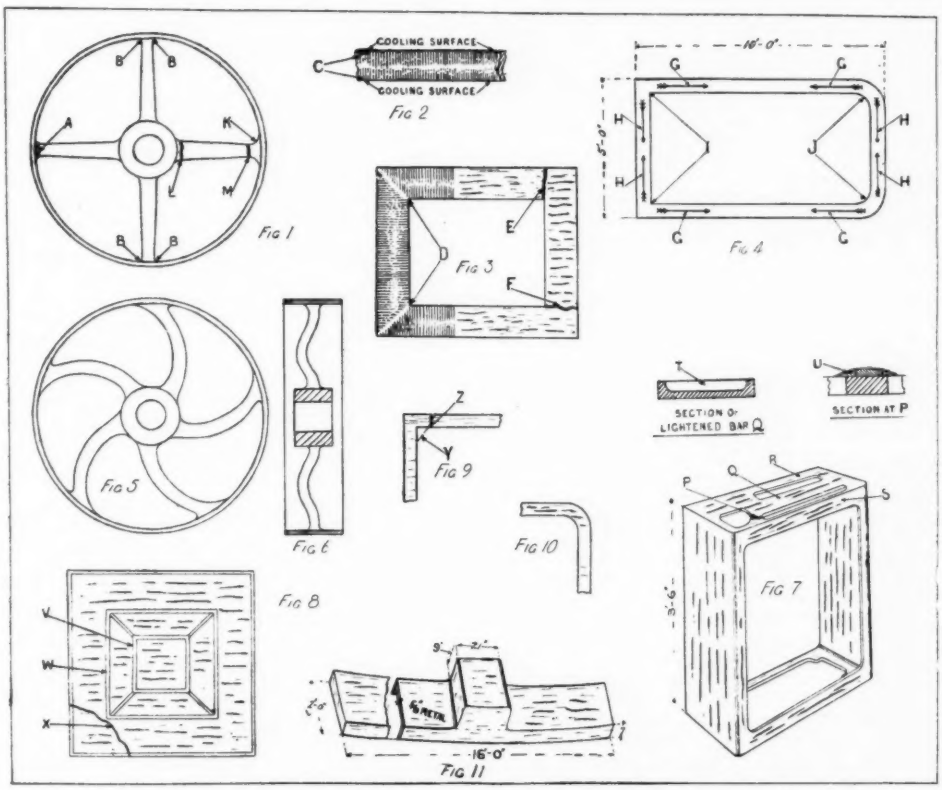
THE BOARD OF TRADE RETURNS for November showed that 11,664 tons of foundry and forge pig-iron, 100 tons iron castings, 397 tons of steel castings, and 1,688 tons of cast-iron pipe were imported; whilst 22,082 tons of foundry and forge pig-iron, 114 tons of grey iron castings, 64 tons of steel castings, and 6,838 tons of cast-iron pipes were exported.

* "Continental Moulding Machine Practice," "F.T.J.," vol. 28, page 452.

Contraction Stress: Cause and Remedies.*

By F. C. Edwards, M.I.Brit.F.

Of all the many forces operating against the production of reliable castings, that of contraction stress is the most insidious and persistent. It is particularly insidious, in that it possesses the faculty of remaining unseen and unsuspected until a suitable moment arrives, when, without warning, it may work incalculable havoc and endanger human life. It is persistent, simply because it is the expression of a natural law—it cannot be defied with impunity. Nevertheless, when clearly envisaged by designer and founder, contraction stress may, to a very great extent, be obviated, or its effects nullified. Like ordinary difficulties it may usually be overcome by intelligent anticipation.



Happily the prime importance of this intelligent anticipation of contraction stress is becoming more and more generally recognised. In the general run of work, one does not now meet with so many monstrosities of casting design as was formerly the case. There are fewer instances in which very sudden changes of metal section make it impossible for a casting to survive its own cooling stresses. Further, the moulder is not perhaps so often called upon to exercise his "practical" knowledge in saving a casting from the fatal effects of, say, purely mathematical design. But contraction stress still levies a more or less constant toll upon the output of castings; and it may safely be assumed that very few castings are made which are not to some extent weakened by what may be called permanent contraction stresses.

Depreciation of Contraction Stress.

Everyone knows that most metals shrink or contract whilst cooling. This shrinkage varies, of course, for different metals. A bar of ordinary cast iron, for instance, of 1 in. square section, and 12 ins. long, contracts about 1-10th in. in length; a steel bar shrinks double this amount. In the case of this plain, straight bar, no contraction stress would be induced in a normal casting. Neglecting, of course, the slight frictional resistance offered by the sides of the mould, the bar would be perfectly free to adjust itself in taking up a shorter length of the mould as it passed through the various stages of cooling. Incidentally, it could be relied upon to support—within fairly narrow limits—a certain load according to its chemical composition.

But, to take a common example, let us suppose that a bar forms one of four arms of a pulley having a comparatively thin rim and heavy boss, similar to that shown in Fig. 1. The thin rim would obviously cool—*i.e.*, freeze first, and the heavy boss last. It therefore follows that the rim, by setting first, would constitute a rigid band of a certain irreducible diameter, upon which the arms would exert a pull in their efforts to adjust themselves to the effect of the still shrinking boss. The arms, in fact, would be placed in tension. Their strength as connecting links between boss and rim would, accordingly, be less than that of the bars cast as separate units. And the casting, as a whole, would be thereby weakened. The actual extent of the weakening effect of contraction stress would depend, of course, upon the relative proportions of rim, arms, and boss, and also upon the composition of the metal. We may consequently say that the casting—and specifically each arm—would be under contraction stress. This stress, it may be added, would render the arms liable to fracture at their juncture with the rim, as shown at A.

A little consideration of the above, in conjunction with other examples, should enable one to solve many of the contraction stress troubles met with in the foundry. The designer of castings, from a clear grasp of the principles involved, should be able to utilise the full strength of the metal he proposes to employ as indicated by the test bar.

The root cause of the contraction stress set up in the example shown in Fig. 1, is, of course, lack of uniformity in the respective metal sections of

* A Paper read before a joint meeting of the East Midlands Branch of the Institute of British Foundrymen and the Leicestershire Society of Engineers, Mr. S. H. Russell presiding.

rim, arms and boss. But there are also present contributory sources of stress, and, in seeking a remedy, it is well to keep these clearly in view. For instance, the rim of the pulley has a greater surface area per unit of metal section than the boss. This relatively greater exposed surface accentuates cooling in the rim, in addition to that induced by the difference in size of the different metal sections of boss and rim respectively. Consequently, there is a wider margin between their respective contractions, and, as a necessary corollary, an increased stress.

Re-entrant Angles.

Another contributory source of stress—or what, to be more precise, may be termed an aggravating factor of stress effect—is that promoted by the re-entrant angles B. Here, to digress a moment, it may be observed that, from examination of many re-entrant angle fractures, the author has arrived at the conclusion that the generally accepted theory of the source of these fractures does not seem to agree with what actually happens. A theory that does not agree with fact, although it may possess a certain academic interest, is of little or no practical use—even if it does not mislead.

Briefly stated, the usual explanation amounts to this:—As molten metal cools, it crystallises on solidification. These crystals arrange themselves side by side (like a line of soldiers, so to speak, with their principal axes in the direction of the flow of heat—or of the heat wave radiated from the body of the metal—*i.e.*, along lines at right angles to the external surface of the casting, as shown at C, Fig. 2. So far, the author of this Paper is in complete agreement. But it is further held, that *as the lines of crystallisation intersect at the corners, they form diagonal planes of separation, along which fracture is liable to occur*—as shown at D, Fig. 3.

Although there is the undeniable possibility of a weakened structure across the corners consequent upon the segregation of a weak eutectoid at the areas last to cool, it is a fact that when fracture occurs it invariably takes a line more or less as shown at E, or F—not (as the orthodox theory would lead one to suppose) in a diagonal direction.

The weak—diagonal—plane theory, then, as an explanation of contraction stress, cannot be substantiated by fact. Foundrymen must seek a more fitting hypothesis. Let them endeavour to visualise, from assumptions based upon common every-day experience, what probably takes place, during cooling, in, say, a frame casting, as shown in Fig. 4.

First, it may be expected that the casting (in grey iron) will be about one inch shorter, over all, and half an inch narrower than its mould. This means that, during cooling, a process of shortening has been going on in each of the four sides. Further (if the mould is of even consistency), we may assume, I think, that this self-adjusting shortening action—in taking up less space consequent upon shrinkage—will operate, in the sides, in the direction of arrows G, and in the ends, as indicated by arrows H. There would be present what may be termed a " contraction pull " towards the centres of the sides and ends respectively. One is further justified, it is thought, in assuming that this " contraction pull " has its source in the cumulative cohesiveness of the metal as it passes from the fused to the solid condition. It would thus appear that the forces G and H, acting at right angles to each other, would tend to produce rupture at corners I. And the " sharper " the corners the greater—because more concentrated—would be the effect of the differently-directioned forces.

This concentration of stress may be obviated. It is an elementary law of physics that a given stress is more easily carried in proportion as the area is increased over which that stress is distributed. This principle applies to the particular case under consideration—and, also, of course, to analogous cases in casting design generally. By increasing the " length of the bend " by substituting a curve for a corner, as at J, we render less concentrated the effect of the forces G and H. Instead of the stress being confined to what almost amounts to a point at corners I, it is spread over the longer radius J.

The incidence of rupture thus not only becomes more indeterminate, but the forces tending to produce rupture are very largely dissipated. The way in which this is accomplished becomes clearer, perhaps, when it is remembered that metal solidifies (and thus acquires strength) from the outside. Regarding bend J, incipient solidification would take place along this edge immediately the job was cast. The rapidly solidifying line of metal round the bend would then assume what may be compared to a kind of chain formation, each " link " of which would be loaded with a share of the tension that, in the former case, was concentrated at I. Moreover, as the interior of the metal at the bend would be in a more or less plastic condition as forces G and H came into operation, each " link " would be in a position to adjust itself, and thus absorb and nullify some of the tension.

It therefore follows, from the foregoing, that not only is contraction stress caused by differences in the relative size, *per se*, of the metal sections at various parts of a casting, but that it may also be promoted—or retarded—by local, or general contour. Applied to the pulley, Fig. 1, a large radius, as at K, should be regarded merely as a local remedy: whilst mitigating the stress at the juncture of rim and arms by distributing it over a greater length, it does not altogether eliminate that which is set up between rim and boss and which may still fracture under its own cooling stresses, at L or M.

Here, it is useful to keep in sight Euclid's axiom that a straight line is the shortest distance between two points. Fig. 1, shows straight arms. Now, by the above axiom, the straight arms represent the irreducible minimum length by which the rim may be connected to the boss. But metal contracts in cooling. Therefore, since the boss cools subsequent to the setting of the rim, the straight arms occupy an untenable position: by Euclid's axiom, they cannot be further reduced in length without fracture. Little wonder, then, that they sometimes give way. Indeed, when it is considered how inevitable is the formation of contraction stress in such circumstances, it seems marvellous that straight armed wheels can be made at all! Unquestionably, contraction stress is always present, even in those castings which may appear to be quite sound.

To eliminate this stress, the *general* contour must be altered. The *design* of the arms must be modified because, as the casting cools, the arms tend to shorten. The connecting link between rim and boss should, therefore, be of such a nature as to allow of variation in its length with the least ultimate overall strain on itself. It should be amenable to contraction pull. In other words, it should exhibit, in itself, the power of length-adjustment: it must be longer than a straight line. This may be attained, either by resorting to the well-known S-shaped arms (Fig 5), or by varying their plane (Fig. 6). In either case, the conditions are favourable to contraction stress elimination—the stress is relieved by the straightening of the arms. It should be noted that, in Fig. 5, five arms are purposely shown, instead of the usual four or six. The odd number tends further to reduce stress by substituting an indirect for a direct pull across the diameter of the wheel.

Contraction Stress Between Cored Holes.

Consider, now, a case which calls for a different line of treatment, but which also contains points applicable to the solution of contraction stress troubles generally. Fig. 7 represents a light frame casting. The sides are ¼-in. in thickness, the front and back are open, and the top and bottom are cored out as shown. When the first casting was taken from the mould, it was found to be fractured at P. Before interfering with the design, several attempts were made by the foundry to overcome the trouble. The body of the mould was eased immediately the casting was set, in order to permit the sides to come inwards. Then the section where fracture took place was chilled, so as to make that part stronger—the better to endure contraction pull. In spite of these, and other special methods adopted, however, the castings continued to fracture, either before or during fettling or machining operations. It was then decided to treat the root of the trouble—to modify the design. And, since this Paper is intended to deal more especially with the

why and wherefore of contraction stress, rather than with a bare recital of results, it is proposed here briefly to touch upon the reasons for the steps taken.

First, it should be noted that the requirements of the component precluded any increase in the width of the narrow isthmus of metal at P. Neither was it permissible to cut through this part completely. Either alternative would have afforded a solution of the difficulty; the first, by rendering adjacent sections more uniform, would have tended to harmonise their respective rates of contraction, and thus reduced or nullified the stress; the second, by removing the metal, would have eliminated the possibility of stress at this point—for where there is no metal there cannot be stress.

It will be seen that the middle bar, Q, the reduced end of which fractured at P, is of a heavier section than the side bars R and S. It naturally follows that cooling—and consequent contraction—would continue with this bar after that of R and S had ceased. This means that these outside bars, when once set, would act as rigid stretchers between the two sides. And each end of the bar Q would, therefore, be fixed before it had finished shrinking. Contraction stress would gradually be induced in this bar, until, with cumulative force, it would overcome the cohesive resistance of the metal at the reduced section P. As an inevitable consequence, fracture would ensue.

From the above reasoning on cause and effect the remedy soon became apparent. Greater uniformity in the rate of cooling of the bars Q, R and S was evidently required. The middle bar was then lightened out, as shown at T—thus speeding up its rate of cooling. The section at P was thickened up on the top, as shown at U. This was almost equivalent to increasing its width (which was not permissible)—it slowed up cooling at this point. No special supplementary precautions were taken in the foundry. The result fully justified the methods adopted. The next and subsequent castings were quite satisfactory; severe tests failing to reveal any sign of fracture.

Modifying Design by Thickening Sections.

In certain circumstances, as, for instance, the addition of metal to a casting with a view to obtaining a stronger component, contraction stress occasionally brings about a diametrically opposite effect to that intended. The author calls to mind a case of this kind, which may here be of general interest.

A plate 5 ft. square, as at Fig. 8, was required to carry a heavier load than it had previously taken. The design was accordingly "strengthened." This strengthening consisted in thickening up and deepening the centre ribs V from ¾-in. wide by 1 in. deep to 1 in. wide by 2 in. deep, and adding similar ribs at W. As the casting was being taken to the dressing shop it collapsed. One corner of the plate, as at X, fell off.

The pulley example, Fig. 1, explains the above very well. The lighter—and more exposed—outside rim cooled first, and assumed a rigid form before the heavy frames of ribs had set. As a consequence, the plate between the ribs W and the outside was subjected to a tension load, which finally overcame the cohesiveness of the metal. It may be fairly assumed that the tension was evenly distributed, but, by the way in which the plate was supported on the wheel-barrow, and the jolting, the tension would probably become concentrated about one corner—the broken one. The remedy was found in reducing both sets of ribs to ¾-in. in width, and taking the frame W down to 1 in. deep, tapering the diagonal ribs down, of course, to suit.

Moulding Boxes.

Contraction stress generally works havoc with square-corner moulding boxes. The trouble is further aggravated where a large fillet is formed in the corner, as at Y, Fig. 9. Fracture occurs, sooner or later, as at Z. A very effective remedy is to make the corners round, instead of square, as shown at Fig. 10. The explanation of this, of course, is the same as that of the "round" corner J, in Fig. 4—the stress is distributed over a larger area, and the shape itself is more accommodating.

Camber Allowances.

Camber, again, is the outward expression of contraction stress in a casting, which primarily arises from a variation in the respective cooling rates of opposite surfaces. An interesting example of this is given in Fig. 11. If the pattern of this frame is rammed up straight, the casting comes out bent hollow on the top (plate) side, as shown.

To obtain a straight frame casting, in grey iron, a camber of 3/16-in. must be allowed when the frame is made without the central projecting pocket. In a semi-steel casting, without the pocket, 5/16-in. is necessary. When the central pocket is required to be cast on, however, and with semi-steel, a camber of 9/16-in. must be given.

In the above case, the lower edge of the ribs, being not only lighter than the top surface, but more exposed to cooling influences, naturally freezes first. This edge, then, may be compared to an iron bar, which, endwise, is practically incompressible. We may assume that, since the upper portion of the casting is more or less plastic when solidification of this lower edge occurs, the latter takes the shape of the mould below it. As cooling continues in the higher strata of the casting, a corresponding diminution of the overall length may be expected. The lower edge, being set—*i.e.*, irreducible lengthwise—contraction stress operates between upper and lower surfaces. This stress forces the lower, first-cooled, hollow-edge straight. And so, a straight casting is produced from a bent mould.

The different degrees of camber allowance which are necessary in this case are, of course, attributable to the differences in composition and design. The grey-iron casting, with its lower ratio of contraction per foot of length, as compared with semi-steel, requires less camber allowance than the latter. The massive projecting pocket, again, accentuates the difference in the rates of top and bottom cooling respectively between frames with, and those without, the pocket. Hence the need, in this case, for greater camber allowance to nullify the increased stress effect.

In these cases of cambering, it is not suggested that the castings undergo any material weakening as a result of contraction stress. Provided, of course, that the rate of cooling is not unduly hastened (a very important proviso), the castings should gradually accommodate themselves to shrinkage requirements.

Danger from Contraction Stresses.

The disruptive forces present in a casting which is under contraction stress are probably quite beyond computation. Nevertheless, one may safely assume that in some cases they reach a very high figure. The release of these forces is occasionally spontaneous—and unexpected. It is then accompanied by more or less danger to life and limb. Within the last few weeks the writer personally experienced a reduced-scale example of this.

An experimental cover plate casting in grey iron, 18 in. dia., with an external rim ⅞ in. by ⅝ in. and a variously-relieved centre plate ⅛ in. thick, came out badly warped. Although the pattern was quite flat across the plate, the casting was found to have bulged outwards at the centre—under the compressive stress, presumably, of the later-cooling rim.

As the writer was in the act of turning the casting over for purposes of examination it collapsed. One piece, about half of the casting, shot away to a distance of from three to four feet. The arm supporting another portion was jerked violently backwards, as from the recoil of a gun, and pieces of the thin centre plate flew in other directions.

Examination showed that the fracture was quite fresh and that the metal itself was clean and sound. The total sectional area of metal fractured was well over 1 sq. in. It is fairly safe to assume, therefore, that in this comparatively small casting (it weighed about 10 lbs.) the stresses present—*i.e.*, regarded as tensional stresses—amounted to at least 10 tons.

Now it should particularly be noted that, beyond the slight strain imposed by its own weight, the casting was not subjected to any form of external shock; it was not being laid down when it flew to pieces, but was being quietly taken up, prepara-

tory to being turned over, from a box part upon which it lay hollow side down. The mere change of position probably supplied the "last straw" to the stresses in the already over-loaded casting.

The above "close-up" (though none too pleasant) demonstration of the reality of contraction stress naturally strengthens the writer's long-held view of the importance of this subject. Such evidence is irrefutable. Surely, if improper design leads, through the operation of contraction stress, to the auto-dissolution of a casting, is it not justifiable to maintain that the highest efficiency of the metal employed can alone be secured where contraction stress is eliminated by proper design?

The incident further suggests that similar impressive methods of instruction might be well worth the consideration of those who formulate curricula for foundry education. From castings especially designed to exhibit extreme examples of stress effect the student would be enabled the better to visualise its operation. Visualising leads to clear thinking. And it is probably quite true to say that the successful design and production of castings require not so much, perhaps, brilliancy of mathematical or metallurgical attainments as good balanced powers of judgment: the ability to form sound deductions from past experience.

Conditions Summarised.

To conclude, contraction stress may be said to be the resultant of conflicting forces operating within castings and tending to cause fracture. These forces arise from the shrinkage which takes place in castings whilst cooling. They come into neutral opposition (thus militating against the strength of the casting) through one, or both, of the following causes:—

(1) Sudden change of form, producing a corresponding change in the direction of shrinkage—as with the re-entrant angle; (2) differences in the size of the respective sectional areas of parts of the casting (especially those in close juxtaposition), thus giving rise to different rates of cooling. These stress forces are further intensified where the general rate of cooling is accentuated. Conversely, the more gradual the general rate of cooling the less pronounced is the effect of the forces upon the casting.

The chief remedy—*i.e.*, means of prevention—lies in adopting sound principles of design. For although the moulder may to some extent mitigate the effects of bad design by suitable gating, or by judiciously exposing parts of the casting, the best results can only be secured where the designer himself has a keen appreciation of these principles. When these principles are flouted, either through ignorance or expediency, there is bound to be a distinct loss of efficiency with the metal employed; the foundry is penalised; scrap is increased; and the user of castings loses faith in their employment when they fracture through causes—to him—quite unfathomable.

DISCUSSION.

MR. PERRY asked about castings 11 ft. long and 6 in. wide, ribs 4 in. on one side and 2 in. on the other, with rounded edge. They came every time in a hollow, and they had had the casting face downwards because of machining. They had been turned over, but still came hollow and warped.

MR. EDWARDS said he had seen hundreds of such castings from 3 ft. long to 18 ft. long, 6 in., 8 in., and 15 in., or even 2 ft. 3 in. wide, and had never had one example of the plate coming round on the unribbed side. How were the castings run?

MR. PERRY: With two runners at each end.

MR. EDWARDS, continuing, said in some of his castings the end cores formed a channel for running, others were run at the side, and the castings were true to $\frac{1}{16}$th of an inch.

A MEMBER insisted that such castings were always worst on the nearest round side when ordinary grey iron was used.

MR. EDWARDS said it passed his comprehension why the castings came as they did.

MR. RUSSELL suggested that the ribs cooled last instead of first.

MR. EDWARDS said he would expect the ribs to cool first; the thicker metal should hold its heat longer than the thin.

MR. RUSSELL agreed, and explained that his suggestion was the trouble.

MR. EDWARDS said that the heavier top in Fig. 11 had a greater contraction capacity than the smaller ribs, and by reducing the length it pulls the bottom up to it because with this being very very thin, just a long strip, there is a cooling surface 2 ft. wide, and surely 2 ft. wide had a greater heat-sustaining capacity than 5 ins. wide. That was only common-sense reasoning.

MR. RUSSELL agreed that the sets must have cooled last and the top must have gone first.

MR. EDWARDS said his firm made all sizes, and very large numbers, and the plate side always came out hollow. There was a large conduction of heat on the top side.

MR. PERRY asked if the sand could act as a reservoir of heat.

MR. EDWARDS explained that the sand intervening would not act as a reservoir of heat but as a radiator, and the heat from the face would radiate away. If the ribs go down into the body sand, they would act as radiators.

M. PERRY, interposing, suggested it would radiate to the centre of the sand and there act as a reservoir of heat.

MR. EDWARDS pointed out that the heat is radiated *away* not *to;* it went away to the outside atmosphere. Heat was taken away from where there was most to where there was least. He believed the ribs acted as a radiator, and heat was radiated away from the surface body of the metal.

MR. LUCAS said he had listened with very great interest, but he was surprised more had not been said about mixtures. He had found that by altering mixtures one could, to a certain extent, overcome a number of these contraction troubles, though, on the other hand, the designers were sometimes at fault.

MR. EDWARDS said the reason he had not touched on mixtures was because contraction affects all mixtures, and if the designer arranged the casting in such proportions as to eliminate these contraction stresses then the casting was stronger if it was a good mixture. If the design was correct in the first place, then the mixture could be chosen accordingly.

MR. RUSSELL said in Fig. 7 he noticed the lecturer used a chill under the weak point. He could not follow the argument; it was an original suggestion to strengthen the weak place by chilling it. He admitted one closed up the grain, but he failed to see how one could strengthen it by chilling. If he wanted to put a chill at all it would be under "P," as obviously "Q" shrank last on account of its greater thickness. The cooling at Q was speeded up by putting on the chill, and the thick section had been converted into a thin section, and the cooling was then normal. The thickening up at P, he suggested, was quite unnecessary. The cure was due entirely to the reduction of area in the metal at Q, and that the thickening up at P, although apparently right, if taken away one would be no worse off.

Referring to Fig. 8, the CHAIRMAN said that where the corner jumped off Mr. Edwards seemed surprised at this, but it was obvious that once that corner had gone all the strain on the casting had disappeared. It was not a good design for cast iron, and he failed to see how the designer had strengthened the plate. It was obvious on this casting that as it cooled the whole of the outside set first, and was exerting a pull in all directions, and the pull was greater between the outside point and the centre because of the greater distance. As soon as that big piece had jumped off, that stress had been removed. That casting, instead of being square, has moved in here and there, with the result that the whole of the outside frame was no longer tensioned.

Pulleys were all under stress, and unless the bosses were artificially cooled, and the rate of cooling thus accelerated, he failed to see how any pulley casting is not under-tensioned when it is cold. He found it necessary to expose the bosses to the air; it was one of their biggest problems to arrange the mixture so that pulleys did not have to be cooled artificially, for if one had to go round baring all the bosses it was a difficult proposition to get round to all in time, and, moreover, added to the cost of production. If the man was careless or did not prepare in time he found troubles developed, and he always traced it back to the fact that the artificial cooling of the bosses had not been

properly done. Every pulley was more or less under tension—the stress was always there and might break during machining.

MR. EDWARDS said chilling was carried out, though he was opposed to it, and had his own ideas on the subject. Pulleys were, no doubt, troublesome, too, in that direction, but to a certain extent it could be helped by judicious running. He was in accord when they said more assistance was needed from the designer.

A DRAUGHTSMAN said he always found it best to work in conjunction with the patternmaker and the foundry foreman. There were some designers who never had been in the foundry, but he suggested that 30 per cent. of the designers took into account differences in contraction stresses.

MR. RUSSELL voiced the thanks of the meeting to Mr. Edwards for his very interesting and stimulating Paper.

MR. EDWARDS, in reply, said it had been a great pleasure to read the Paper. In putting together one of these Papers he found it was really an education to the individual, and many points became clear as they endeavoured to put new thoughts on paper. One became more exact in one's ideas, and he thought it would be better if more members would prepare Papers, but unfortunately many of those with the longer experience were disinclined to do so, and it was a great pity, for they could give most interesting information.

Fixing the Responsibility for Foundry Defects.*

By JOSEPH LEONARD, Past-President of the Belgian Foundrymen's Association.

In view of the large number of discussions the object of which is to fix the responsibility for all the troubles to which we are subjected at the present time, the moment seems favourable to attain the same object in the foundry. The truth is that there are far too many wasters, and far too little inquiry into the causes of the defects; the troubles, in fact, are too easily dismissed by those involved as being in the natural order of events. About fifty years ago some of the "big men" in the foundry world prophesied that fifty years later technical experts would be available who could determine the cause of all the troubles peculiar to the foundry. There was reason for the prophecy, because up to the present day the problem has been in evidence. It is only since the inception of the French Association Technique de Fonderie that the important discussions, which throw so much light on the subject, have been possible.

The responsibilities are of two kinds, administrative and technical. The first includes the general manager, works manager, foremen and undermanagers, etc. Present methods of manufacture tend to reduce the demands on the artisan's skill; rapid production often means more superficial attention than formerly. The necessity for reasoning is becoming constantly less with the introduction of mechanical methods. Production must be cheap—that is, rapid. The casting must be saleable, an elastic term that falls far short of the ambition of the artisan of 15 or 20 years ago, when his first care was to turn out a highly finished piece of work. This loss of pride of the worker in his work is a feature of the present day that is much deplored by the old, skilled craftsman. There is, however, no reason why the workman should not regain his pride in first-class work; if the industry has been transformed, then the workman must transform his ideas and methods. The means for acquiring knowledge are within reach of all; professional and industrial schools, associations, technical journals—nothing is missing. These facilities are used too little, and those who are engaged to direct the workers find them intelligent, it is true, but lacking the knowledge that would enable them to grasp what the teacher has to impart. The workman is often responsible for much of the trouble that occurs. Much trouble, too, can be traced to the foremen, and it is disappointing to find that the efforts over several years have done little to staff the foundries with men who would welcome research and organisation.

It is necessary, as quickly as possible, to scrap the ideas that some weird influence is responsible for certain defects, and that the position of foreman is the reward of long service, to be regarded as a sort of rest cure. However, the right type of foreman is on the increase; foremen who are really leaders and instructors, and not merely overseers. Nevertheless, the fact remains that only in rare instances are defects subjected to methodical and persevering investigation. One reason for this is the tendency to use the foreman as an administrative rather than a technical agent. A foreman should spend 90 per cent. of his time in the shop, and the examination of wasters should be one of his principal duties. It is in this respect that most foremen fail.

To examine a waster, break it in small pieces with a sledgehammer, cut pieces off with a saw; approach the problem in the manner of a surgeon conducting a post-mortem examination. Inquire into the circumstances of the trouble; mark the pieces for identification; attempt to establish the basic features of the defect, and to link up the circumstances with the general procedure of the foundry. The systematic examination of the rejects is essentially the duty of the foundry manager. A microscope will enable him to distinguish between an inclusion of sand and one of slag, yet in how many foundries is a microscope to be found? It is recorded that in one foundry the introduction of a microscope and its intelligent use resulted in a reduction of wasters by 50 per cent. The duty of the foreman is to verify each day the weak points in the current methods, and as long as he does not do this he is entirely responsible.

There is, too, the responsibility arising from a false conception of a laboratory which, working on samples without any indication of the conditions under which they were made, is consequently unable to come to any sound conclusions on the mechanical and chemical properties of the casting. It is necessary for the laboratory to keep in the closest touch with the foundry, or to become itself a foundry for experiments.

This practical realisation is already a fact in the laboratories attached to the forge which have their heat-treatment furnaces and carry out on a small scale the work that is done in the forge on a large scale, or which evolve on a small scale methods of working which are to be reproduced on manufacturing lines in the forge.

Examples of the grossest defects, persisting because the laboratory has come to some negative conclusion based on erroneous data, are only too common in foundry practice.

Responsibilities of the second order attach to the technical staff. There is the question of sponginess, to determine in each case whether the mould or the metal is at fault; is it due to "blowing" or contraction? The inability to answer this is due to our comparative ignorance of the processes, owing to the lack of effort towards the systematic examination of the phenomena of casting. There is the inveterate habit of only considering the metallurgical side of the operation, forgetting that in the analogous case of steel nothing would have been learnt but for the constant search for improved methods. It is not enough to produce from the cupola a material having the required properties; these properties must be maintained in the face of harmful influences exerted in the mould and during casting; the founder must do all in his power to reduce these to a minimum. A case is recorded of a series of aluminium alloys investigated by one of the most modern firms, which, after considering innumerable reports, came to the negative conclusion that no one alloy was superior to the others. It appears that all their conclusions were based on the mechanical properties only, in arriving at which no account whatever had been taken of the casting temperature.

The questions of inclusions is also typical—sand or slag? Many mistakes have been made, yet a simple examination with a magnifying glass would have settled the matter definitely. Defects due to contraction are too often summarily dismissed with a vague reference to "shrinkage."

* Extract of a translation of a Paper read before the 4th Annual Congress of the Association Technique de Fonderie.

Cast iron is subject to a contraction of 0.8 to 1.0 per cent. Certain aluminium alloys have as much as 1.2 to 1.3 per cent; others do not exceed 1.0 per cent. Even massive castings in iron or bronze may remain fairly homogeneous, whereas the same casting in aluminium may contain cavities representing 25 per cent. of the total volume, although aluminium has a contraction only 50 per cent. greater than iron, and even less than some of the bronzes. Some day an accidental discovery solves such problems, and enables the trouble to be eliminated, yet the best microscope has not been able to distinguish what a pair of intelligent eyes has easily perceived. Often the situation can be summed up in the words of a founder who was always ready to give technical advice, but who, when asked to solve a foundry problem, replied: "I ignore the cause, but look for the remedy." The same defect may be caused in many ways, and the remedies which lie in their removal are just as numerous. The following list, though incomplete, gives typical defects and the possible causes:—

Short Run Castings.—(1) Metal too cold; (2) sections too thin; (3) runners not big enough; (4) runners badly placed, giving too long a run for the metal; (5) air locks owing to insufficient venting; (6) mould too hard or too damp, or not sufficiently permeable; and (7) pressure of the metal too low, owing to insufficient height of runner head.

Blow-holes may be caused by:—(1) Metal too cold; (2) metal too hot; (3) damp sand; (4) teeming too quickly; (5) difficulty of keeping runner full; (6) mould or cores not properly dried; (7) moulds or cores not properly vented; (8) air holes getting plugged with metal; (9) wet or rusty chaplets; (10) core sand too rich in volatile matter; (11) badly designed pattern; (12) excess of paste in assembled cores; and (13) badly placed gates and risers.

Sand Inclusions may be due to:—(1) Runner box badly made or carelessly finished; (2) sand falling into the runner whilst it is being handled; (3) crushing of prints; and (4) parts of the mould washed away by the incoming metal, sand may be too weak, mould not rammed enough, or the fall of metal too great.

Broken Castings.—(1) Accidental breakages during dressing, etc.; (2) breakages due to shrinking, metal too thin or difference in thickness of adjoining parts too great; (3) cores or re-entrant angles of moulds too hard; (4) core irons and grids placed too near the surface.

External Defects.—(1) Sand too coarse; (2) sand badly mixed; (3) blacking insufficient or of poor quality; (4) sand too wet; (5) mould not rammed enough; (6) pattern in poor condition; and (7) metal cast too hot.

So it might be continued. Everyone will be able to prepare a list covering his own speciality. Such a list can be used as a guide to the tracing of the cause of each fault, and the cause, when found, will enable the responsibility to be fixed with some degree of certainty.

Shrinkage, Composition and Contraction of Cast Iron.

In some tests which Professor Bauer and Herr Karl Sipp have made for the purpose of studying the influence of silicon, manganese, phosphorus, and sulphur on the shrinkage and contraction of grey iron, they have confirmed the influence of the separation of graphite. The shrinkage is in direct relationship to the contraction, but above all the important point is the casting temperature which directly influences the shrinkage. Pumping is often resorted to for the purpose of overcoming shrinkage. This has for its object the maintenance of a passage between the interior of casting and the feeding head, but in order that this passage can remain open it is obvious that the metal must be definitely hot. Generally speaking, to reduce, if not suppress, the shrinkage, it is necessary to employ a low-sulphur mixture, which composition favours the separation of graphite, and consequently reduces shrinkage. It is also necessary to cast at a suitable temperature and utilise modern moulding conditions.

Molecular Equilibrium in Grey Iron Castings.*

BY IVAN LAMOUREUX.

Taking into consideration the stresses that they have to withstand the cast iron members of machines receive too little attention. In spite of the improvement in the quality of the metal that has resulted from the progress in chemistry and metallurgy, very little, indeed, has been done to ensure molecular or internal equilibrium. Indeed, apart from the empirical methods adopted in the foundry, it may be said that nothing has been done. To investigate this subject properly it is important to use a metal of a high degree of purity and small contraction.

The investigation may be sub-divided into the influence of shape or form, the influence of design, examination of current means for increasing the strength of castings. The empirical methods affecting the result are, the quality of the mould and of the metal, method of casting, the use of chills and chill moulds, annealing, etc. Considering the question of form and proportions it is found that they are fixed almost solely by empirical methods. Although machine parts formerly made of wood are now made of metal the matter of design remains practically unchanged. With the exception of machines of recent development, which have never been made in wood, a great lack of originality and of understanding of the properties of cast metals is found. Thus, an electric motor, a steam turbine, the cylinders of a motor car or of an aeroplane, all have the metal disposed in a rational and scientific manner. But in machinery of ancient origin little effort has been made to make the design conform to the strength of the material. In effect it may be said that the proportions of cast members have been based on the assumption that the wood pattern had to be strong enough to withstand the stresses that the finished casting was to bear. In certain districts there are still to be found wooden brackets carrying shafting, tilt hammer shafts made of the trunk of a tree, or lathe beds consisting of two wood beams faced with chestnut wood. There is really little difference between these old, wooden members and their early counterparts in metal.

An examination of the structure of the metal composing such parts will show that the crystallisation of the graphite differs according to the variations in thickness. Even if the thicknesses are made uniform there are still the variations in fins and webs. If the corners are rounded with fillets the metal may become spongy, and if the corners are sharp the crystals tend to set themselves at right angles to the cooling surfaces so forming planes of weakness. The cast-iron column is an exception, in that in following the cylindrical form of the old, wooden columns the correct shape has been attained. When properly cast, the crystals can assume their normal arrangement without weakening the column. The attainment of this result, however, was accidental rather than the outcome of scientific study. If an opening is left with sharp corners cracks will occur at the corners following the planes of weakness caused by the arrangement of the crystals.

Speaking generally, the instructions issued to the designer of the machine are, "To make it slightly larger than the smallest and a little smaller than the largest." Or, perhaps, he is given an illustration from the catalogue of another firm, and is told to base his design on that. It is not to be expected that the draughtsman has an exhaustive knowledge of moulding, especially when many important laws are ignored by the foundrymen themselves. So little importance is attached to the moulder's part in the production of the casting that his advice is seldom, if ever, sought. The design being completed the casting is simply ordered from the foundry, the staff of which has no option but to use the pattern that is sent; it is left to him to do what he can to avoid cracks, sponginess, blow-holes, etc. The casting may correspond to the design, but its strength may be seriously reduced by severe internal stresses. The

* Translated and extracted from a Paper presented to the 4th Congress of the Association Technique de Fonderie on behalf of the Association Technique de Fonderie de Belgique.

conscientious draughtsman will explain that his stresses have been calculated on the basis of 2 tons per square inch for iron and 4 tons for steel in tension. If the casting were free from internal stresses these allowances would give an ample margin of safety, for the worst iron should have a tensile strength of at least 6 tons per square inch. If the casting breaks under normal service it is because it is weakened by internal stresses.

No better illustration of the power of combined effort can be furnished than the results obtained by scientists, engineers and chemists during the war. Their combined efforts applied to foundry problems resulted in an extraordinary increase in the strength and regularity of foundry products. Methods of testing have been greatly improved and test pieces can now be taken from the actual castings, so eliminating one source of error. The use of iron containing a large proportion of steel and special irons have enormously raised the quality of castings. Microscopic examination as a supplement to chemical analysis has proved a great step towards the thorough examination of materials. But, after all, if these methods of examination and control do prove the quality of the metal as a metal, they are of little help in fixing the quality of the casting. Without ceasing to study methods of testing it seems necessary to devote some efforts to the problem of producing castings which shall be free from internal stresses. It is not enough to have an iron of high mechanical strength if, owing to faulty design, it is in parts subjected to severe initial stresses.

As a rule the irons having the greatest mechanical strength also have a high rate of contraction, a fact which increases the danger due to internal stresses.

Remedies.

The contraction of the metal after casting results in the crushing of such parts of the mould and cores as are surrounded by the metal. As soon as the casting is taken out of the sand and is seen to be free from cracks and flaws it is considered good. But very little account has been taken of the enormous effort that the metal has exerted in order to compress the sand. The remedy here would be to adopt means to permit the free and complete contraction of the metal. Sometimes a fin, a runner or a riser may hinder contraction, or, often a core iron will do the same, with the result that fracture occurs. The sand itself, if tightly rammed without spaces for compression will hinder shrinking.

Quality of Metal.

The quality of the metal and its purification have been studied by Brunelli with much success. Founders are awake to the fact that any impurity allowed to pass into the mould will cause local weakness wherever it lodges. A number of processes, acting principally on the sulphur, have greatly increased the strength of iron. MM. Varlet and Piedbœuf have quoted striking figures on this point as a result of their research on segregation and oxidation. It may be mentioned that by the use of pure irons having low contents of sulphur and phosphorus and with little shrinkage most of the usual troubles may be overcome.

Method of Casting.

If the metal is cast hot it will raise the mould to a high temperature which will be favourable to slow cooling and the formation of coarse grain: contraction will be slight. If cast cold the metal undergoes a kind of chilling by contact with the mould, and the proportion of combined carbon will be increased: the amount of contraction will also be high.

At present, casting temperature is a matter of experience varying according to the quality of the iron and the shape and size of the casting. It would be well to formulate rules relating to casting temperatures.

According to whether a casting is run from one point or another it will be in a state of molecular equilibrium or in a state of internal stress; it may even break after cooling. A pulley run at the boss will cause cracks at the arms, whereas if run at the rim it will be successful; the metal running round the rim heats it up considerably, so retarding the rate of cooling which thus tends to almost uniform solidification. It was noticed that motor car piston rings were frequently machineable only on the runner side, the opposite side being very hard owing to the sudden cooling at that point.

Some pit shaft lining segments were found to be broken, although they had only been lying on the ground since being taken from the mould. There was a riser at the centre of the segment which was cast on the flat, and it was found that the centre was becoming re-heated by the metal, with the result that the corners solidified first, and the segment was broken by the subsequent shrinking of the middle. By arranging risers at the four corners instead of the middle the conditions would have been improved. It is not uncommon for extremely large and massive castings to fail spontaneously without being subjected to any external stresses whatever, the cause being due to internal stresses which exceed the strength of the material. It is not necessary to mention obvious defects due to gas in the mould, or cores, the presence of sand washed away in the runner, displacement of cores, etc.

Chills and Denseners.

Certain castings which have massive parts joined to thin walls can only be dealt with successfully by the use of chills rammed in the mould at the same time as the pattern. M. Varlet has mentioned the value of iron blocks covered with a thin layer of moulding sand in making cores for very thick castings. In chilled castings of wheels, with arms, a difference in texture has been observed in the neighbourhood of the arms; fracture frequently occurs at these points at which, too, the greatest amount of wear takes place. An example of perfect molecular equilibrium is furnished by the special chilled wagon wheels in which the arms are replaced by corrugated discs. Whenever a casting of irregular thicknesses is to be made means must be taken to ensure uniform cooling by the use of suitably placed chills or by running the metal at a special point.

When moulding lathe beds of the usual form a camber must be given to the working face which is cast downwards, otherwise the slow cooling of this greater mass would cause warping. This camber may amount to about $\frac{1}{32}$th of an inch per ft. If the lower face is chilled the camber may be reduced to about one-fifteenth of this amount. It has already been proved that there is no mechanical reason why perfect internal equilibrium should not be attained, so making any initial camber unnecessary. This crude method of giving an initial camber is universally employed, and often gives rise to serious trouble; sometimes the casting will break when removed from the mould and sometimes the bed will take a new camber after machining—it may be a few months later. From this it would seem that internal equilibrium is slowly attained, and, when complete, the lathe bed will have to be machined afresh. It is possible to make lathe beds in the form of two stiff tubes joined at the ends by rigid box castings. This design would utilise the rational cylindrical section which gives perfect internal equilibrium and at the same time is easily and accurately machinable. It may be added that lathe beds as now made are run at the working faces, that is, the part having the greatest thickness is exposed to the stream of hot metal, a fact which still further retards the rate of cooling.

Annealing.

It has been suggested that the proper annealing of grey iron castings will greatly improve their quality; this may be a solution in the future, but it must not be forgotten that the price will be considerably increased.

Tumbling.

There is evidence that the cleaning of castings by tumbling in a revolving barrel increases their strength due to the repeated blows on every part which tends to restore the internal equilibrium. Unfortunately this method can only be applied to castings of moderate size, and in which there are no sharp corners.

In conclusion it may be said that in spite of the improved methods of testing the material no scientific method has been devised to evaluate the mechanical strength of the finished casting. Rather than using iron of great mechanical strength and large shrinkage, attention should be directed to the pure irons of low contraction, the use of which will reduce the internal stresses and approach more nearly the ideal of molecular equilibrium.

XUM

The Selling of Castings.—VI.

By VOYAGEUR.

SPECIAL CAMPAIGNS.

The special campaign, which now comes up for discussion, is intermittent, or, rather, occasional. It does not consist of spending extra money on a mere *extension* of the general selling campaign, nor does it during the period of its operation replace or supersede it. This form of campaign has a certain definite moment at which it may be said to begin, and also an equally definite moment at which it may be considered as ending. The purpose of the general campaign is to maintain and increase steadily the total annual volume of sales. It goes on from day to day, whatever the changes in the state of trade. But the special campaign has a more straightforward and immediate goal. When this goal is reached, the special campaign finishes.

At this point it becomes necessary to enumerate the five motives for the inauguration of a special campaign. They are as follows:—(1) To lend a stimulus to the general sales, which may be sluggish; (2) to introduce castings of a different or novel kind; (3) to reinvigorate weakening interest in a special kind of castings; (4) to point out new purposes for which the castings may be employed; and (5) to open up new markets.

A special campaign is also initiated sometimes for the purpose of clearing out old stocks, but in the case of founders this necessity will seldom, if ever, arise. It will be as well to take each motive in turn, and show in closer detail why special campaigns are necessary in these special instances, and how they may serve their purpose.

The stimulation of general sales has been placed first in the list because it is, on the whole, the most usual excuse for starting a campaign of this sort. A founder often finds that over a given period—it may be months, or it may be years—his sales have either increased very slowly indeed, have stood still, or have even declined. Now, continuous progress in selling is essential to the well-being of any business, and unless the sales year by year show a fairly steady rise, there is a possibility of failure. Usually a decline or insufficient increase in sales is due to a loss of vigour and enterprise on the selling side of the business. Unless a tonic is given quickly, a disastrous loss may at any time be made. Merely to increase the amount expended on general selling activities may not be sufficient to restore sales to their normally healthy condition, simply because such an increase does not strike the market sufficiently forcibly to arouse its attention. But the special campaign, being more precise in its organisation and aims than the general campaign, often provides the tonic the business needs. It can concentrate effectively on its immediate objectives. Therefore it should differ in both design and execution from the selling activities usually adopted, though it will at the same time aid and strengthen these, in the same way as a brilliant article in a journal makes the reader more attentive to its other features.

The special campaign is invaluable for introducing a new kind or quality of castings to the market. By offering to buyers something in striking contrast to the usual form of selling, it arouses interest, and that is exactly what a new kind of casting needs. It sometimes happens that the introduction of a new produce, as distinct from the minor alteration of an older one, embraces the creation of a new manufacturing section. A new production department should, by all the unwritten laws of marketing, receive its appropriate share of the money available for selling. The founder has to make up his mind whether to spend this share on a little extra advertising, etc., as part of the general campaign, or whether to spend it in opening a special campaign intended to focus attention directly on the new product. This latter is, in the writer's opinion—and he speaks with much experience—the better and more likely method.

When general sales keep up pretty well, but a certain kind of casting suffers a marked falling off in demand, a special campaign will be found a cheap and efficient way of reviving orders. Thus, the foundry may be busily engaged on castings for shipbuilding and general engineering purposes, but may be short of orders for locomotive or automobile castings. In such a case the special campaign will be directed against the railway engineers who order these goods.

Similarly, the special campaign will be found an ideal instrument in opening up new markets, or in teaching the market to use the castings for different purposes. Special campaigns are flexible, opportune, and concentrated, all three of which are great advantages when a special selling objective is to be attained.

These campaigns require, however, planning as thoroughly as that of the general campaign. They should be organised and executed apart from all reference to the latter, just as if it were the only kind of campaign in existence. Its scope, *i.e.*, whether national, geographical, occupational, industrial, and so forth, and its aims should be clearly defined beforehand.

One must now examine ways and means. There are seven important points to be settled before beginning operations:—(1) Are the castings to be specially advertised? (2) How long is the campaign to run? (3) Will it be necessary to get out special literature? (4) Will circularising prove effective? (5) What persons are to be tackled, and in what way? (6) Will more salesmen be required? and (7) Will it be necessary to offer special prices or terms during the period of the campaign?

Generally, advertising is the heart and soul of a special campaign. It is this that enables it to strike a note of difference. Advertising in special campaigns must go straight to the point, and concentrate on the particular kind of castings it is desired to sell.

How long the campaign is to last depends on the time taken to reach the goal. Sometimes the question is answered by the absorption of all the money set aside for the furtherance of the campaign. Sometimes it is not easy to say when sales have been sufficiently revived, when the new castings have been made sufficiently well known, when new markets have been sufficiently opened up. In this matter the sales manager must use his own discretion. On the other hand, the termination of the campaign may be automatically determined, as when the contracts, to obtain a share of which a campaign may have been instituted, have been run; or when the buying season (in those industries where demand is seasonal) has ended for a time.

Special campaigns are nearly always helped, and but seldom hindered, by the preparation of literature designed solely to further their aims. It is not wholly wrong to make use of literature that already exists, but in the main, when finance will allow, it is better to preserve the note of difference and use literature specially written for the purpose.

Circularising is a useful adjunct to any campaign, and might be used by founders more often and more opportunely than it is. The remaining questions can best be answered by the sales manager himself as a result of a reconsideration of his market analysis results.

Production of Metals in Ontario.—A Reuter's cable from Toronto states that according to the bulletin of the Ontario Department of Mines the metalliferous production of the province for the first nine months of the current year exceeded in value that for the corresponding period last year by $4,407,000, or 14 per cent.

Trade Conditions at Krupps.—A correspondent who has just visited Krupps' Works at Essen writes:—"So far as I can gather the works are pretty slack, though the railway departments have some large orders at the moment which will carry them on for a couple of months or so at full pressure, after which, unless more orders come along they will have nothing to do. The works policy seems to be to work at full capacity for as long as possible and then to close down, instead of spreading the work over a longer period by working short time. In this way they are no doubt able to secure orders because they can maintain good deliveries.

Fatigue in Metals.

In a lecture to the British Acetylene and Welding Association, at the Old Colony Club, Aldwych, London, on Thursday (December 4), MR. H. J. GOUGH, of the National Physical Laboratory, discussed the problem of fatigue in metals. He defined "fatigue" as the process by which metals could be fractured by repetitions of cycles of stress or strain whose magnitude was insufficient to cause failure at a first application. Failure under a single loading was rare, and its cause could usually be definitely assigned to gross errors of design, faulty material, or to an unforeseen shattering overload. An eminent Scandinavian engineer had once stated that 90 per cent. of engineering failures which he had investigated could be ascribed to fatigue.

Discussing the phenomena associated with fatigue, Mr. Gough said that if one of the standard works on the strengths of materials of construction were consulted, 90 per cent. of the book would be found to have been devoted to a study of the phenomena accompanying fracture due to a unidirectional straining action of increasing severity. A few pages might be devoted to the effect of repeated stresses, and sometimes even these few pages contained some mis-statements of fact. He ventured to predict that similar text books in the future would devote increasing attention to the fatigue properties, until some day a classical book would be produced in which statical phenomena were studied in close relation with fatigue phenomena.

Types of Stresses and Tests.

In the laboratory, said the lecturer, the fatigue properties of metals had been studied using three main types of applied loading, *i.e.*, alternating direct stresses, alternating bending stresses, and alternating shearing stresses, and the typical testing machines for each of these loadings were the Haigh, the Wöhler, and the Stromeyer machines respectively, the principles of which were illustrated.

Typical endurance tests were then discussed, and the conclusion arrived at by Mr. Gough was that, for ferrous metals, the existence of a fatigue range was definitely indicated, and, further, that the range was developed at less than 20 million reversals of stress. It would be expected, he said, that the lessons derived from fatigue tests on ferrous metals might be applied equally to non-ferrous metals, but recent research had shown that this must not be assumed to be true. Tests carried out in America had led to the conclusion that there existed, at present, little evidence of the existence of a fatigue range for non-ferrous metals in general.

With regard to the use of fatigue tests as quality tests, the lecturer pointed out that, of the acceptance tests with which materials of construction had to comply, the most common were the tensile test and the notched-bar impact test. For reasons, chiefly of economy, the results recorded in an acceptance test were restricted usually to (1) elastic limit (rarely); (2) yield stress; (3) ultimate strength; (4) elongation at fracture; (5) reduction of area. If a family of carbon steels, for example, were tested, these quantities varied in an irregular manner, but it could be said, in general, that with increasing carbon content the ultimate strength increased and the ductility decreased. The resistance of a metal to withstand shock could be affected profoundly by heat treatment. Moreover, in many cases faulty heat treatment could not be detected from the results of a static tensile test. There was little doubt that faulty microstructure was most clearly revealed by a notched-bar impact test, of which the form usually adopted was the Izod test. The question arose as to whether these tests could be dispensed with if the fatigue range of a material had been determined. Mr. Gough said he had data of the results of reversed bending tests made on 106 metals, collected from the records of three distinct laboratories. The results were expressed in a number of slides, which showed that there was no relation between the fatigue range and the tensile limit of proportionality, the yield stress and the impact value (single blow to fracture) respectively. He then discussed the relation between the fatigue range and the ultimate tensile strength, and concluded that the only mechanical property with which the range for reversed bending stresses could be correlated was the ultimate tensile strength. It might be mentioned that, as the Brinell number was directly related to the ultimate tensile strength, a very accurate estimate of the fatigue range might be obtained by carrying out a ball indentation test on a specimen.

The relative fatigue-resisting properties of two metals bore no relation to their notched-bar values. Hence it would be assumed that the fatigue range was not affected by faulty heat treatment if the ultimate strength were not affected. This, also, had been proved by several investigators, and some results bearing on this point were given, the important point brought out being that if a material were to be subjected to repeated stresses and to occasional heavy shocks, the judicious choice of that material must be made after a careful consideration of its tensile strength and its shock-resisting properties. In other words, the fatigue test in itself was not a quality test. For instance, if a motor-car designer were to attempt to reduce the weight of a propeller shaft by using a very high-carbon steel in the hardened condition, and thus obtaining increased fatigue range at the expense of ductility, that designer would be asking for trouble. He would certainly encounter it, owing to the usual appalling mis-use of brakes and clutch.

Effect of Speed.

Considering speed effect, or the effect due to frequency of the cycle in its relation to the fatigue-resisting properties of materials, the lecturer pointed out that from the earliest days of locomotives one of the chief tendencies of the design of prime movers had been towards the improvement of the power-weight factor. This had been rendered possible, in the first place, by a general increase in the values of working stresses, which had been rendered practicable by the development of greatly improved materials of construction, and secondly, by employing high working speeds. The results obtained by various investigators of speed effect showed that any adverse effect on the fatigue range of an increase in frequency of repetition might be discounted, a conclusion of vital importance to engineers.

With regard to permanent deformation resulting from repetitions of a safe range of stress, the lecturer said that the subject had been studied fully by Bairstow, and a summary of his results on axle steel was given. This showed that permanent set resulted from every range of safe stress, except reversed stresses. The amount of this set depended on the maximum stress of the cycle. When this stress was equal to, or greater than, the static tensile yield stress of the material, the permanent set was equal to that obtained in a static test. When the maximum stress of the cycle was less than the tensile yield stress, the set obtained due to repeated stress exceeded that resulting from the first application of the stress. The practical significance of this result might be expressed by saying that if, in any structural or machine component subjected to repeated stresses, permanent set could not be permitted, then the maximum working stress must not exceed the limiting stress for reversed stresses, if the latter were less than the static elastic limit, or the static elastic limit if its value were less than that of the limiting stress.

Surface Scratches.

Discussing the effect of surface scratches and discontinuities of section on the fatigue range, the lecturer pointed out that it was an established fact that surface defects whose effect on the static ultimate strength was negligible, might considerably affect the fatigue-resisting properties of the same material. Important research had recently been carried out by Thomas on the effect of scratches and of various workshop finishes upon the fatigue strength of steel, and his results were as follows:—

Type of finish.	Estimated max. reduction in Fatigue Strength.
	Per cent.
Turned	12
Coarse file	18 to 20
Bastard file	14
Smooth file	7½
Coarse emery (No. 3.)	6
No. 1 emery	4
Finer emery (O or FF) ..	2 or 3
Fine carborundum	2 or 3
Fine ground finish	4
Accidental scratches .. .. (maximum found)	16

Thus great attention should be paid to surface finish of machine parts subjected to repeated stresses. Also care should be taken to avoid sudden changes of section. It was his experience that the effect of a right-angled shoulder or collar on a Wöhler specimen reduced the fatigue range by 50 per cent. If a change of section were necessary, however, care should be taken to connect the two unequal sections by a smooth transition curve, which should be as long as possible.

Effect of Stresses upon Microstructure.

As to the effect of repeated stresses upon the microstructure of metals, the author reviewed the work done, and the theories which had been held as to the mechanism of slip in crystallographic planes, fatigue, etc., and subsequently referred to the results of research conducted at the N.P.L., and published last year. In this research they had studied the effects on the microstructures of several metals of repetitions of reversed, direct stresses, pulsating tensile and pulsating compressive stresses, and reversed tortional stresses, and had obtained indisputable evidence of a large amount of slip under *safe* ranges of stress of every type. It might be considered as proven, he said, that plastic strain—as measured by strain measurements or observed as slip bands—could and did occur when a metal was subjected to repetitions of a safe range of stress. It was also an established fact that the result of such plastic strain was to strengthen and to harden the material. This was shown by an increased tensile strength and an increased resistance to ball indentation. Yet, when failure occurred under repeated stresses, the fatigue crack undoubtedly started in one of the heavily deformed areas, and its course followed similar areas. Therefore, he concluded that the strain-hardening effect of slip did, at some stage, reach a maximum, and failure then commenced in the hardened region. The long-sought-for key to the riddle of fatigue failure lay in a correct understanding of this apparent paradox. The N.P.L. had just completed a series of lengthy tests on single crystals, and, he believed, had solved the problem. He could not refer to this work, however, in fairness to his colleagues, as the results were in course of publication, but he was firmly of opinion that many hitherto baffling aspects of the problem had been solved.

Discussion.

MR. K. S. MURRAY (managing director, British Oxygen Company, Limited) referred to an account he had read recently of the effect of what was really fatigue on some welded gas vessels which had been subjected to alternating stresses through the pulsation of a compressor. Originally there was a slight defect in the weld, which would have been hardly perceptible, and would probably have had no effect on an ordinary structure, but on these particular vessels, subjected to the pulsation of the compressor, that defect gradually developed, until ultimately a rupture took place in the weld. The two morals to be drawn from that were (1) to avoid the use of any kind of welded vessel in connection with a gas compressor, and (2) that welders must do thoroughly conscientious work if they were welding vessels to be used under gas pressure. The weld was not an oxy-acetylene weld.

MR. V. C. FAULKNER (President of the London Branch of the Institute of British Foundrymen) said that he had been taught, some 20 years ago, that fatigue was brought about by three main causes: (1) Over-annealing; (2) cold working; (3) high phosphorus. The last only applied to steel. He asked whether there were any other causes of fatigue. He believed that in welded materials it was not the weld which failed, but the material just adjacent. Perhaps, in welding, they had this over-annealing, and the remedy then became obvious—they must heat-treat the material to be mended after welding. That was a *sine qua non*. As to cold-working, perhaps, owing to the difference in temperature between the actual weld itself and the body of the material there could be something which would resemble cold-working. The third factor, high phosphorus, could perhaps be avoided if a filling material were used, as certain types of welding demanded. Cast iron was the most difficult material to weld, and there the problem was complicated, because there was graphite in the structure. Graphite had no strength, and was like so many voids in the material to be welded.

MR. C. COULSON-SMITH believed it was taken for granted, as the result of research carried out by Dr. Rosenhain at the N.P.L., and other work, that if there were a segregation of phosphorus it was detrimental, and caused brittleness, but if perfectly disseminated throughout the mass it tended to increase tensile strength. Also, was it not a fact that a theory had been put forward that fatigue was not only due to the slipping of crystals, but to stresses caused by weathering or corroding?

MR. GOUGH, replying to the discussion, said that if the phosphorus in steel were distributed uniformly through the material, the more phosphorus in the metal the higher the tensile strength and fatigue strength, but if there were large segregations of phosphorus they corresponded to slag, and there would be a fatigue crack, starting with the phosphorus. As to cold-working, he mentioned the case of a boiler plate, in which cold-working had raised the ultimate strength and fatigue strength, although shock resistance was decreased. The chief result of over-annealing was to produce very large grains, which would have the effect of bringing up the ratio of endurance limit to tensile strength higher than in any other type of material. On the other hand, if they gave the material a very sudden shock and started a crack there was very little resistance to the crack spreading through it. If they refined the structure by normalising they would usually increase the shock-resisting properties, but not necessarily the fatigue limit. In reply to Mr. Coulson-Smith, he would say that in iron fatigue failure was not a corrosion failure in any way. The result of experiments at the N.P.L. on single crystals showed that the process was essentially one of slip.

MR. FAULKNER asked if the crystals were stronger than the inter-crystalline boundaries, or weaker, and why a crack went through a crystal instead of round the crystal boundaries.

MR. GOUGH pointed out that metallurgists were divided into two camps, one camp holding that there was nothing between the crystals, and the other that there was some material between the crystals which was stronger than the crystal material; the same chemical composition, but of different phase. There was not the slightest evidence, however, that there was anything between the crystals.

Wheel Mould Cores.

The general tendency in foundry practice is to build up moulds by assembling cores. This is particularly true of wheel moulds, and the question has been studied by Mr. R. D. McRae, of 54, Lorne Street, Hamilton, Scotland, who has been granted a Patent (No. 222,004) entitled "A Machine for Making Segmental Cores for Use in the Casting of Wheels and other Circular Bodies." We believe a better description would be either "An Apparatus" or "An Adjustable Core Box for Making Segmental Cores, etc." The apparatus is so constructed that 8-, 6- or 4-spoke wheels can be made by easily carried out adjustments, whilst similar elasticity is provided in other directions. The stripping of the core is extremely simple. The apparatus is of the type which comprises a continuous, circular table-like base to support the core and an outer peripheral wall, built up of a number of narrow sections to provide the length of wall required. The side plates are formed as adjustable cheeks so as to form any angle, and are pivoted to swing on a central spindle in order that they may be used for a segmental core of any angle.

U.S. Diesel Engine Industry.—The manufacture of Diesel engines in the United States showed a large increase in 1923 over 1921. A total of 1,313 Diesel engines were turned out in 1923, with an indicated horsepower rating totalling 199,161. In 1921, 785 Diesel engines were manufactured with a total indicated horsepower rating of 96,116.

SIEMENS' STEEL PROCESS

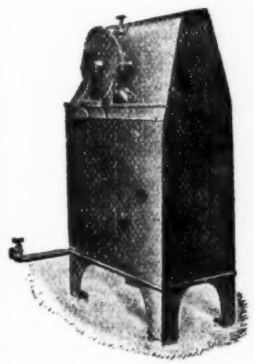
BOILER, SHIP and BRIDGE PLATES, etc. ANGLES and all forms of Sectional Bars. TYRES and AXLES to all requirements. CASTINGS of all kinds and of Largest Sizes. FORGINGS of every description. BILLETS, BLOOMS, RAILS.

SPECIAL STEEL FOR CONSTRUCTIVE PURPOSES.

The STEEL COMPANY OF SCOTLAND, Ltd.

Head Office: 23, ROYAL EXCHANGE SQUARE, GLASGOW.
Works: HALLSIDE, NEWTON and BLOCHAIRN, GLASGOW.
CONTRACTORS TO HOME, COLONIAL AND FOREIGN GOVERNMENTS.

Established 1872. *Telegraphic Address: "Steel, Glasgow."*



Pays back what it costs.

···TRADE··· SIROCCO ···MARK···

STEAM TURBINE HEATER UNITS

The Fan is driven by a turbine, and the exhaust steam from the latter is used to heat the air. The Fan driving power is thus provided free.

On account of its flexibility and the ease with which it is installed, the "Sirocco" Steam Heater Unit is an ideal method of heating Factories and Workshops.

THE STEAM THAT DRIVES THE FAN HEATS THE AIR.

DAVIDSON & CO., LIMITED

SIROCCO ENGINEERING WORKS, BELFAST

LONDON BIRMINGHAM MANCHESTER GLASGOW BRISTOL CARDIFF NEWCASTLE-ON-TYNE

GANISTER, CUPOLA BLOCKS, FIRE BRICKS, FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

Trade Talk.

THE FYLDE WATER BOARD have placed a contract for the supply of 1,070 tons of cast-iron segments with the Stanton Ironworks Company, Limited, Nottingham.

A LICENCE under the Non-Ferrous Metal Industry Act, 1918, has been granted to J. W. Strahan, 54, New Broad Street, London, E.C.2.

HOLLINGS & GUEST, LIMITED, Thimble Mill Lane, Birmingham, announce that their standard scrap metal bundling press has now been reduced in price to £100.

MESSRS. C. VALVIS AND S. T. CASEY, iron and hardware merchants and importers, 20, St. James' Street, Liverpool, trading under the style of Valvis & Casey, have dissolved partnership.

COX & DANKS, LIMITED, who have been engaged on the salvage of German torpedo-destroyers at Scapa Flow for the past six months, have now decided not to continue salvage work until after the winter.

THE CONTRACT for the steelwork required in the construction of the viaduct over the Taff near Merthyr Station has been secured by Sir William Arrol & Company, Limited, King's Dock, Swansea.

PLATT BROS. & COMPANY, LIMITED, of Oldham, have secured the contract for the equipment of the new Wye Mill at Shaw, near Oldham. This comprises 97,000 ring spindles, with all the preparatory machinery.

AT A MEETING of the Birmingham Branch of the Institute of British Foundrymen, held on December 6, Mr. D. Wilkinson read a paper on "The Manufacture of Malleable Iron." The president (Mr. T. Vickers) presided.

THE TENDER of Dorman, Long & Company, Limited, for the construction of the proposed new bridge over the Tyne has been endorsed by Newcastle City Council. Five tenders were received, as follows: Dorman, Long & Company, £571,225; Cleveland Bridge and Engineering Company, £604,421; Sir William Arrol & Company, £606,454; Sir W. G. Armstrong, Whitworth & Company, £743,229; Motherwell Bridge Company, £743,938.

Company News.

A. Cherry & Son, Limited, 25, Hill Street, Humberstone Gate, Leicester.—Capital £2,000 in £1 shares. Ironfounders. Directors: A. Cherry and A. H. Weir.

Collins Improved Firebars, Limited.—Capital £1,000. Directors: H. F. Anns, G. H. Collins and G. S. Thompson (secretary), 16, Eastcheap, E.C.

Farrow & Sons, Limited.—Capital £20,000 in £1 shares (5,000 cumulative preference). Engineers, merchants and exporters, etc. Permanent directors: E. P. Farrow, W. P. Farrow and J. A. Thompson (secretary, pro tem.), 29, Welland Terrace, Spalding.

Irish and Continental Engineering Company, Limited, Parnell Street, Thurles.—Capital £2,000 in £1 shares. Directors: E. T. O'Mears, W. J. Dwan, F. E. Ford and J. F. O'Mears.

Pure Metal Manufacturing Company, Limited.—Capital £3,000 in 5,800 preference shares of 10s. each and 2,000 ordinary shares of 1s. each. Directors: A. A. Smith, Riversdale, Romiley, near Stockport; G. W. Herbert, 6, Albert Street, Hyde.

John Brown & Company, Limited.—Interim dividend, 2½ per cent. on ordinary.

W. & T. Avery, Limited.—Interim dividend, 5 per cent., less tax, on ordinary shares.

British Thomson-Houston Company, Limited.—Interim dividend, 7 per cent. cumulative preference.

Pinchin, Johnson & Company, Limited.—Interim dividend, 6½ per cent. per annum, less tax, on preference shares.

Atlas Steel Foundry and Engineering Company, Limited.—Profit, £2,342; debit of profit and loss account, £11,533, carried forward.

Armstrong Whitworth Development Company, Limited.—Profit, £76,435; brought forward, £12,399; available, £88,835; dividend, 15 per cent., free of tax, on ordinary shares; carried forward, £1,640.

J. & E. Wright, Limited.—Divisible balance, £25,078; final dividend, 5 per cent., making 7½ per cent., free of tax, for twelve months; reserve, £5,000; carry forward, £6,890.

Millom & Askam Hematite Iron Company, Limited.—Net profit, £40,655; brought forward, £15,563; total, £56,218; preference dividend for 12 months, £24,500; preference dividend to March 31, 1924, £12,250; carry forward, £19,468.

John I. Thornycroft & Company, Limited.—Dividend, 3 per cent. on preference shares, making 6 per cent. for year; carry forward, £49,384.

Shotts Iron Company, Limited.—Brought forward, £58,059; profit, £38,173; depreciation, £30,762; income-tax, £14,150; interim dividend on preference shares, £2,241; dividend on preference shares for second half of year, 2½ per cent., less tax, making 5 per cent. for year; carry forward, £46,838.

Contracts Open.

London, S.W., December 23.—400 laminated bearing springs (13 plates, 4 in. by ½ in.), for the Madras and Southern Mahratta Railway Company, Limited. The Company's Offices, 25, Buckingham Palace Road, Westminster, S.W.1. (Fee, £1 1s., non-returnable.)

London, S.E., December 19.—Copper bolt, etc., for the Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1., viz., copper bolt, hard rolled staybars.

Eastbourne, January 5.—Supply and fixing of new tidal and sluice valves, for the Corporation. The Borough Engineer's Office, Town Hall, Eastbourne. (Fee, £1 1s., returnable.)

Tamworth, December 22.—One 10-ton single-cylinder steam roller complete with water lifter, three-tyne scarifier, 18 in. wide driving wheels, full-length canopy with side and end curtains, also sleeping-van with the usual appurtenances to accommodate three men, for the Rural District Council. Mr. B. L. Wright, engineer and surveyor, 29, Lichfield Street, Tamworth.

Obituary.

MR. R. DUNCAN, of Dalchonzie, Comrie, senior partner of the firm of Ross & Duncan, engineers, and formerly member of Parliament for the Govan Division of Lanarkshire, died on December 4. Mr. Duncan was a native of Govan, and was apprenticed to the engineering firm of Alex. Chaplin & Company, then of Cranstonhill, and now of Helen Street, Govan. On completing his apprenticeship he entered Glasgow University, and, after a two years' course, took his C.E. certificate. After turning his attention towards the practical side of engineering he became a draughtsman in the firm of Dubs & Company, locomotive engineers, Polmadie, whose works are now part of those owned by the North British Locomotive Company. Afterwards he joined the firm of W. & A. M'Onie, Govan. In 1876 he began business for himself in company with Mr. William Ross, under the name of Ross & Duncan, ever since well known as that of one of the leading marine engineering firms on the Clyde. The partners took over an establishment in Hydepark Street, employing a working staff of about a dozen. In their hands the business at once began to expand, and in 1882 it was transferred to new premises in Whitefield Road, Govan, where it flourished still more. Now the firm employ, in busy times, about 450 men, and the works cover an area of about 14,000 square yards.

MR. A. TANNETT WALKER, who at one time was prominently associated with his native city of Leeds, died on December 4 at Grange-over-Sands, where he had lived for the last four years. The death of Mr. Walker, at the age of 73, recalls the history of a large engineering establishment in Leeds and its ultimate collapse. The business of Tannett, Walker & Company was founded in 1862 by the late Mr. Benjamin Walker, in association with Mr. Robert Tannett, who died some years later. On the death of Mr. Walker, in 1891, the control of the business devolved upon his two sons, Mr. Arthur Tannett Walker and the late Mr. Fred Tannett Walker, and in 1898 it was converted into a limited liability company. In the height of its prosperity it was one of the most important engineering concerns in Leeds, with a world-wide reputation for all kinds of hydraulic machinery, several hundred hands being employed at the extensive works in Goodman Street, Hunslet. But a period of bad trade intervened, and in 1913 the creditors were called together, the outcome of this step being the dissolution of the company and the complete abandonment of the works.

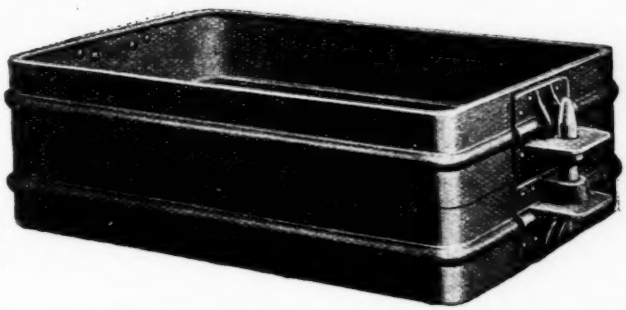
Iron and Steel Output.

The National Federation of Iron and Steel Manufacturers in their Statistical Bulletin for October report that the pig-iron production in the United Kingdom in that month amounted to 586,400 tons, compared with 569,200 tons in September, the daily average being thus slightly less than in September. There was a net gain of one to the number of furnaces in blast at the end of the month, this being the first occasion since February when an increase in the number of furnaces operating has been reported. Steel production in October amounted to 678,500 tons, compared with 645,000 tons in September.

YOU CAN TURN OUT
BETTER CASTINGS AT LESS COST
BY USING

Sterling

ROLLED STEEL
MOULDING BOXES



STERLING FOUNDRY SPECIALTIES, Ltd.
London Office:
13, VICTORIA ST., S.W.1. Sterling Works, BEDFORD.

SECTIONS OF STERLING ROLLED STEEL BAR SHOWING THE SOLID RIB AND STIFF SAND LEDGES.

SECTIONS OF STERLING ROLLED STEEL BAR SHOWING THE SOLID RIB AND STIFF SAND LEDGES.

Telephone: 21, Penistone. Telegrams: "Durranns, Penistone."

ESTABLISHED 1863.

JAS. DURRANS & SONS., LTD.

Phoenix Works, Penistone NEAR SHEFFIELD.

BLACKING
PLUMBAGO
CORE GUM
WHITE DUST
COAL DUST

Manufacturers of

FOUNDRY EQUIPMENTS.

Ladles, Cupolas, Fire Bricks, Ganister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Write for illustrated catalogue on Blacking and Foundry Requisites, also for our latest Price List.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Business in the Cleveland iron market during the current week has tapered off to very small dimensions in view of the near approach of Christmas, without much possibility of recovery to more active conditions before the advent of the New Year. In reviewing the present position, consideration must also be given to the fact that some fairly heavy buying in recent weeks has secured consumers' supplies for a month or so ahead, and consequently makers are by no means disturbed by a period of seasonal quietude. The export trade in the Tees-side area continues on an unsatisfactory scale. Continental exchange rates have suffered another relapse, but on the whole the tone of the market remains fairly cheerful, with a confident feeling that after the turn of the year business will be better, both for home and abroad. Values are perhaps a trifle easier, but show no real shrinkage. At this week's market, No. 3 G.M.B. could be done at 81s. 6d. per ton, according to the position of the works and the brand required. No. 1 was round about 86s. 6d., and No. 4 foundry and No. 4 forge in the region of 80s. 6d. and 80s. per ton respectively.

Movements in the hematite markets are also restricted in scope, but there has been of late a steady diminution of stocks in makers' yards on account of contracts already booked. In the meantime values are somewhat irregular, though within a narrow margin. In one or two cases, where producers have still pretty heavy stocks, 88s. will be accepted for East Coast mixed numbers; in others as much as 89s. per ton is demanded. But a fair average figure is 88s. 6d., with No. 1 6d. per ton more. No change is marked in conditions on the West Coast market, Bessemer mixed numbers being now quoted at 99s. 6d. delivered Glasgow, 102s. 6d. delivered Sheffield, and 107s. 6d. per ton delivered equal Birmingnam.

LANCASHIRE.—The majority of buyers of foundry pig in this locality having already provided sufficient supplies to carry them over the remainder of the year are holding off the market, business consequently is slowing down considerably, especially during the period usually appropriated to the annual stocktaking. Many makers also are not anxious to sell at the present prices beyond January, although it is possible to buy No. 3 Derbyshire foundry pig at 90s. delivered up to the end of March. Local sellers of pig here are very confident that prices will not be any lower, and that if any movement occurs it will be to a higher level next year. Of course, it was in anticipation of this that so many Lancashire ironfounders bought pig-iron last month, for it is fairly certain that there was no corresponding rush on the part of consumers to buy castings.

THE MIDLANDS.—Fairly active conditions are reported in the markets for foundry iron in these districts, but sellers as a general rule are declining forward business on any scale of magnitude. The ironfounders in the Black Country are finding demand considerably better, and certain sections are very busy. Meanwhile, ruling quotations are steady, as follow:—Derbyshire No. 3 foundry, 82s. 6d.; Staffordshire No. 3 foundry, 87s. 6d.; Northants. No. 3 foundry, 76s.

SCOTLAND.—Only a limited amount of business is passing in the Scotch foundry pig markets, with little prospect of improvement until the year has turned. The market is, perhaps, a shade easier, although prices are quotably unchanged at 90s. per ton for No. 3 at the furnaces. There has been practically no business done in Middlesbrough iron, and the makers' price of No. 3 at Grahamston to-day is 86s. 6d. There is no trace of any business having been done in Continental iron, either foundry or basic, during the past week, and prices of these irons are 84s. per ton f.o.t. Glasgow district for the former and 85s. 6d. f.o.t. steelworks for the latter.

Finished Iron.

Some stimulus to buying in this section of the market has been recently imparted by the extensive contracts for railway rolling stock placed with South Staffordshire manufacturers of finished material, whose works will benefit when the specifications are issued shortly. Throughout the year the outstanding feature about this branch of the trade has been the call for marked bars, and at present the makers of this iron have no difficulty whatever in getting their figure of £15 per ton f.o.t. The price for crown iron is £12 15s. and nut iron £11 15s., delivered, but these figures stand little chance against the foreign prices when it is possible for the consumer to wait for the latter. The Belgian figure for iron is £7 12s. 6d., with better grades at £8 per ton delivered. The demand for iron plates is better, and prices have stiffened to £16 basis for ¼-in. thick and up.

Steel.

The lull, usually observable, preceding the Christmas holidays now pervades the steel market, and matters at Sheffield are very quiet. Continental competition in semis has revived, home makers now experiencing difficulty in obtaining orders so freely as was lately the case, and the market is consequently unsettled by the low prices quoted for imported material. Business in tinplates has been inactive all round during the past week.

Scrap.

The outlook in the various markets for scrap metal is now regarded as more hopeful than for some time past, and the opinion is confidently expressed that the New Year will disclose a revival of demand for foundry material. In Lancashire the market for cast-iron scrap remains quiet, but the foundries have not yet got to work on the supplies of foundry pig recently bought, and are not using very much substitute metal. In some of the Lancashire centres of consumption there is rather too much cast scrap on offer, and weak holders are inclined to accept low prices; but this is not the case everywhere, and prices vary a good deal in different districts. In Manchester fairly good lots of broken machinery can still be bought at about 80s. per ton, but for special lots up to 85s. per ton is asked. In the Scottish markets machinery cast-iron scrap is again quiet, but the price is maintained at 90s. per ton, and for ordinary quality to the same specification, *i.e.*, pieces not exceeding 1 cwt., 85s. per ton. Old cast-iron railway chairs have changed hands this week at 89s. per ton.

Metals.

Copper.—Favourable American advices of late have had an encouraging effect upon values of standard copper on this side, and the market now evidences a more stable upward tendency. New bull buying has been attracted on a fairly large scale, and America quickly responded to the gradual improvement in the London market. A moderate revival of consumers' buying is also manifest in fine copper, of which fair lines were taken for electrical use. From the relatively low terms that were accepted at the outset for wire bars c.i.f. for early December arrival, prices moved up steadily, the official quotation for wire bars being restored to £69 10s. Current quotations:—*Cash*: Thursday, £64 7s. 6d.; Friday, £64 17s. 6d.; Monday, £65 12s. 6d.; Tuesday, £65 12s. 6d.; Wednesday, £65 12s. 6d.

Three Months: Thursday, £65 7s. 6d.; Friday, £65 17s. 6d.; Monday, £66 15s.; Tuesday, £66 12s. 6d.; Wednesday, £66 15s.

Tin.—The improvement recently noted in values is continued in the market for tin, the heavier American buying having served to stimulate new speculative interests, which has been sustained on the strength of the Eastern market, where sellers have generally been able to get terms considerably above London parity. Continental buying, chiefly German, has been a feature, and no doubt this has helped the liquidation of part of the bull account. The Welsh tin demand is very limited at the moment, and there is no doubt that the fall in silver has brought some Chinese offers, which, however, have been easily absorbed. Current quotations:—*Cash*: Thursday, £256 5s.; Friday, £259; Monday, £258 15s.; Tuesday, £261 5s.; Wednesday, £260 10s.

Three Months: Thursday, £259 7s. 6d.; Friday, £262; Monday, £262; Tuesday, £264 10s.; Wednesday, £264.

Spelter.—Renewed strength has been a feature in the market for this metal, and a fairly active business has been done, with values on the up-grade. Consumers have booked orders a little more freely of late, following the reduction in quotations, but they are not so well placed as they would like to be for distant deliveries. For that reason, while taking zinc a little more readily, they are not buying more than required for their obligations. Current quotations:—*Ordinary*: Thursday, £36 1s. 3d.; Friday, £36 7s. 6d.; Monday, £37 8s. 9d.; Tuesday, £37 12s. 6d.; Wednesday, £37 7s. 6d.

Lead.—The market for soft foreign pig continues irregular, the wide fluctuations in values having justified the opinion held among consumers that the big rise in the metal had gone rather further than was warranted by conditions. Rumours of delay caused by the shipping strike in shipments from Australia have been largely responsible for the anxiety to cover immediate requirements, and a feature of the market has been the comparatively light dealings in December lead. Current quotations:—*Soft foreign (prompt)*: Thursday, £41 15s.; Friday, £42 5s.; Monday, £43 5s.; Tuesday, £43; Wednesday, £42 12s. 6d.